SCIENCE

FRIDAY, MARCH 21, 1913

CONTENTS

Avogadro's Law and the Absorption of Water by Animal Tissues in Crystalloid and Colloid Solutions: PROFESSOR JACQUES LOEB 427

The Spread of the Brown-tail and Gypsy Moth 439

The New Geological Survey Building..... 440

Scientific Notes and News 440

University and Educational News 445

Discussion and Correspondence:—
The Yellowstone: PROFESSOR W. S. FRANKLIN. *Alleghany Valley Erosion:* EDWARD H. WILLIAMS, JR., *Academic Freedom:* PROFESSOR J. E. CREIGHTON 446

Scientific Books:—
Alder and Hancock on British Tunicata: PROFESSOR WM. E. RITTER. *Miller's List of North American Land Mammals: J. A. A. Euler's General Chemistry of the Enzymes:* PROFESSOR C. S. HUDSON..... 451

Special Articles:—
Mitochondria in Ascaris Sex-cells: EDWARD E. WILDMAN 455

The American Association for the Advancement of Science:—
Section E—Geology and Geography: PROFESSOR GEO. F. KAY..... 456

Societies and Academies:—
The American Mathematical Society: PROFESSOR F. N. COLE. *The Academy of Science of St. Louis:* PROFESSOR GEORGE O. JAMES. *The Botanical Society of Washington:* DR. C. L. SHEAR. *Philosophical Society of the University of Virginia:* PROFESSOR WM. A. KEPNER..... 460

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

AVOGADRO'S LAW AND THE ABSORPTION OF WATER BY ANIMAL TISSUES IN CRYSTALLOID AND COLLOID SOLUTIONS[1]

I. STATEMENT OF THE PROBLEM

FIFTEEN years ago, on an occasion similar to this, the writer stated that if the constitution of matter is the main problem of the physicist the constitution of living matter is the main problem of the biologist. To-day I will discuss the applicability of Avogadro's law, one of the most fundamental laws underlying the constitution of matter, to a group of life phenomena, namely the regulation of the amount of water in animal cells and tissues. According to Avogadro's law equal volumes of gases at the same temperature and pressure contain an equal number of molecules; or, in other words: In the gaseous state equal numbers of any kind of molecules enclosed in equal volumes have the same pressure at the same temperature. This law was extended to solutions by van't Hoff in the following form: All dissolved substances produce upon a membrane which prevents their diffusion but allows water to diffuse an osmotic pressure equal to that which would be produced by gaseous matter containing the same number of molecules in the same volume. Combining Avogadro's and van't Hoff's law we may state that the same number of molecules of any kind of matter produce at the same temperature and volume the same pressure upon the walls which prevent their diffusion.

[1] Read by title in the Botanical Section of the Cleveland meeting of the Society of American Naturalists, December, 1912.

It is well known that Pfeffer constructed cells of clay whose pores were filled with a precipitate of ferrocyanide of copper and that the walls of these cells allowed water, but not salts or sugars, to diffuse through. When such a cell with semi-permeable walls is filled with a salt or sugar solution and put into a larger vessel containing distilled water, the latter will diffuse into the cell and raise the level of the liquid until the hydrostatic pressure is equal to the osmotic pressure of the solute. Such a cell could therefore be used for the determination of the molecular weight of any dissolved substance which can not pass through its walls.

Now, if it be true that living cells are surrounded by semi-permeable walls and that the osmotic pressure regulates the exchange of water between the cells (or tissues) and the liquids of the animal body, it should also be possible to use living cells as osmometers for the determination of the molecular weight of sugars or salts.

The reader is aware that this possibility had already been demonstrated for plant cells (*Tradescantia*) by de Vries before van't Hoff had discovered the applicability of Avogadro's law to liquids and that de Vries's observations induced van't Hoff to interest himself in this problem. At the time of de Vries's work there was a difference of opinion concerning the molecular structure of the sugar raffinose and three different formulæ were offered, one giving the sugar the molecular weight 396, the second 594 and the third 1,188.

By determining the concentrations of cane sugar and raffinose which cause plasmolysis, *i. e.*, the shrinking of the protoplasm of the *Tradescantia* cells, de Vries found that a 3.42 per cent. cane sugar solution and a 5.96 per cent. raffinose solution had the same physiological effect. On the basis of the assumption that solutions with an equal attraction for water have the same number of molecules in equal volumes, and since the molecular weight of cane sugar is 342, the molecular weight of raffinose should be $(5.96/3.42) \cdot 342 = 596$. In this way it was established by de Vries that the molecular weight of raffinose was 594 and the formula $C_{18}H_{36}O_{16} + 5H_2O$ the correct one.[2] This formula for raffinose is to-day accepted by the chemists.

II. Examples for the Applicability of Avogadro's Law to the Osmotic Behavior of Animal Tissues

The oldest and, perhaps, best demonstration of the fact that the exchange of water between animal cells and the surrounding liquid is determined by Avogadro's law is furnished by Hedin's experiments on red blood corpuscles. His method consisted in the determination of the changes of volume of red blood cells in various solutions. The volume was determined with the centrifuge.

Hedin[3] first established the fact that the blood cells do not change their volume if put into solutions of the same molecular concentration as the blood, no matter what the nature of the solution, provided that the substance does not enter the cell.

VOLUME OF BLOOD CORPUSCLES IN

.15m	KNO_3	NaCl	$NaCH_3COO$	$CaCl_2$
	34.4	34.4	34.3	34.3

All the solutions had the same osmotic pressure as a .15m KNO_3 solution. The agreement of the results is such that the use of red blood corpuscles as osmometers for the determination of the molecular

[2] After Hoeber, *Physical. Chemie d. Zelle u. Gewebe*, 1911, p. 86; De Vries, *Jahrb. f. wissensch. Botanik*, Vol. 14, p. 427, 1884.

[3] Hedin, *Skand. Arch. f. Physiologie*, Vol. 5, pp. 207 and 238, 1895. (The tables quoted here are taken from Hamburger, "Osmotischer Druck und Ionenlehre.")

weight of dissolved substances would be warranted.

The following gives the results of the change in the volume of red blood corpuscles in isosmotic concentrations of KNO_3 and NaCl.

Concentration	Volume of Blood Corpuscles in		Difference, Per Cent.
	KNO_3	NaCl	
.08m	48.6	50.2	—1.6
.1	46.3	48.2	—1.9
.12	43.2	44.2	—1.0
.13	42.5	43.4	—0.9
.14	41.4	42.2	—0.8
.15	40.2	41.0	—0.8
.16	39.9	40.4	+0.5
.17	39.7	39.6	+0.1
.18	39.4	39.2	+0.2
.20	39.1	38.0	+1.1
.22	39.2	37.3	+1.9
.24	38.7	36.8	+1.9
.26	38.3	36.5	+1.8
.30	37.2	36.8	+0.4

The agreement is best for .17 KNO_3 which was equi-molecular with the blood used in this case.

But even for concentrations differing from the molecular concentration of the blood the agreement is still surprisingly satisfactory, considering the fact that solutions which differ widely in their concentration from that of the blood corpuscles are liable to modify the permeability of the cells, as we shall see later; and that this injurious effect is influenced strongly by the chemical nature of the substance.

We may, therefore, state that equi-molecular solutions of salts cause practically the same change in the volume of red blood corpuscles.

The experiments on red blood corpuscles have the disadvantage that we can not well discriminate between the living and dead cell. In this respect the experiments on muscle are much more satisfactory. It had been known through the experiments of Nasse that in an m/8 solution of NaCl (and other salts of Na) the frog's muscle keeps its weight. The writer showed sixteen years ago that (within certain limits of time) the same is true for solutions of LiCl, KCl, $MgCl_2$, $CaCl_2$, $SrCl_2$ and $BaCl_2$ equi-molecular with an m/8 NaCl solution, while in solutions of lower concentration the muscle absorbs, in solutions of higher concentration it loses water. He concluded from this that the absorption of water by the muscle is determined by van't Hoff's law.[4] The number of molecules in solution, and not their chemical character, determines the exchange of water between muscle and surrounding solution.

I was interested to find out with what degree of accuracy Avogadro's law determines the exchange of water in the muscle. For this purpose a series of experiments were made with NaCl and various sugars in concentrations slightly below or above the point of isotony.

CHANGE IN WEIGHT OF A FROG'S MUSCLE WITHIN ONE HOUR IN PER CENT. OF ITS ORIGINAL WEIGHT IN

.1	.125	.150	.175m NaCl
+3.9%	0%	—1.9%	—1.9%

In a .1m solution of NaCl the muscle takes up water, in a .125m solution it keeps its weight, in a .15 solution it loses water. That the loss in a .175m solution was in this case not greater than in a .15 solution was accidental and probably due to the fact that different muscles vary somewhat in their osmotic pressure, owing to their previous history—*e. g.*, whether they had been more or less active. The influence of these inequalities can be eliminated by making a large number of experiments.

But, although the muscle is not quite as accurate an osmometer as the red blood corpuscles, the fact that its exchange of water is determined primarily by Avo-

[4] Loeb, *Pflüger's Archiv*, Vol. 69, pp. 14–20, 1897.

gadro's law is illustrated by the following experiment.

In an m/8 solution of NaCl 85 per cent. of the molecules are dissociated into ions. If we want to prepare solutions of non-conductors (*e. g.*, sugars) of the same osmotic pressure as an m/8 NaCl we must choose a concentration of .231m. At a concentration of a sugar solution of .200m a muscle must absorb water, while at a concentration of .250 and above it must lose water. We have made this experiment for three sugars, a mono-saccharide, grape sugar; a disaccharide, cane sugar; and a trisaccharide, raffinose. The following table gives the change in weight of the muscle in these solutions in one hour.

	.2m	.25m	.3m	.35m
Grape sugar.....	+2.9%	−1.6%	−4.1%	−7.7%
Cane sugar.....	+3.8%	−1.2%	−1.3%	−6.1%
Raffinose	+1.7%	−3.3%	−5.3%	−8.9%

The turning point between loss and gain of weight lies for all those sugars between the same limit of molecular concentration, namely, between .2 and .25m; and the most important fact is that the value for the three different sugars lies between the limits calculated on the assumption that the exchange of water between muscle and surrounding solution is determined by Avogadro-van't Hoff's law. As long as we are dealing in biology with only qualitative results there may always be some doubt in regard to the applicability of such a law to a life phenomenon, but if the results come out quantitatively identical with those calculated we may be pretty sure that the law holds good for these cases.

Miss Cooke[5] investigated in the writer's laboratory the gain of weight in the muscle in hypotonic and hypertonic NaCl solutions. Near the isotonic point the amount of water increases at first slowly in almost a straight line with the dilution; but as the solutions become more dilute the amount of water taken up increases at a rate far greater than the rate of dilution of the solution. Miss Cooke points out that this may be due to some secondary change in the muscle caused by the dilute solution or the entrance of water into the muscle. In hypertonic solutions irregularities were noticeable, due probably to the varying condition of rest or activity in the individual muscle before the experiment.

The following gives a series of determinations in equi-molecular solutions of NaCl and cane sugar, by R. Webster.[6]

CHANGE IN WEIGHT OF FROG'S GASTROCNEMIUS AFTER ONE HOUR IN EQUI-MOLECULAR SOLUTIONS OF NaCl AND CANE SUGAR.

NaCl		Cane Sugar	
	Per Cent.		Per Cent.
m	−17	1.67m	−40
m/2	−13	.87m	−27
m/4	− 7	.45m	−12
m/8	0	.23m	− 1
m/16	+13	.12m	+11
m/32	+25	.05m	+26

While the gain in weight of the muscle in the equivalent hypotonic solution is practically the same in NaCl and cane sugar, in the hypertonic solutions of cane sugar the muscle loses more than in the equi-molecular solutions of NaCl. This is probably due to the fact that solutions of cane sugar have an abnormally high osmotic pressure and that this anomaly seems to be more pronounced the higher the concentration.

The number of animal organs in which the applicability of Avogadro's law can be tested is limited, since for this purpose it is necessary that the tissues have no pores or capillary spaces in which the surround-

[5] *Journal of Physiology*, Vol. 22, p. 137, 1898.

[6] R. Webster, University of Chicago Decennial Publications, Vol. X., p. 105, 1902.

ing solution can adhere. Tissues with a spongy structure can not be used for exact measurements. Siebeck[7] has recently been able to carry out a series of experiments on the kidneys of the frog. The measurements were not as satisfactory as in the case of the red blood corpuscles and the muscle, but sufficiently accurate to leave no doubt of the main result, which is as follows: In solutions of NaCl, NaBr, LiCl, and LiBr, KCl, $CaCl_2$, $MgCl_2$ and cane sugar equi-molecular with a .7 per cent. Ringer solution the kidneys neither take up nor lose water. Siebeck points out that these solutions have no other quality in common except the same number of molecules, and that hence the osmotic pressure determines the exchange of water between the kidneys and the surrounding solution. Mathews's experiments indicate that the same is true for the living nerve.[8]

According to Meigs[9] smooth muscle preparations do not behave as if they were surrounded by semi-permeable membranes; but the smooth muscle of the stomach which he used in his experiments can not be obtained in as natural a condition as that in which striped muscle or blood corpuscles or the kidneys are available. It would be of interest to repeat these experiments on smooth muscle, which can be obtained with as little alteration of its natural surface, as, *e. g.*, striped muscle or kidneys or red blood corpuscles.

III. ABSORPTION OF WATER BY COLLOIDAL SOLUTIONS

The natural media surrounding animal tissues are solutions which contain dissolved proteins in addition to certain salts. Some authors seem to take it for granted that the force by which such protein solutions or colloidal solutions in general absorb water is not determined by Avogadro's law, and some go so far as to state that the regulation of the distribution of water between cells and blood is solely determined by the proteins and not by the salts. Such ideas are contradicted by theory as well as by experiment. We can show by the use of living cells as osmometers that colloidal solutions behave exactly as Avogadro's and van't Hoff's laws demand.

Avogadro-van't Hoff's law demands that a grammolecular solution of any dissolved substance contain the same number of molecules—leaving aside temporarily the facts of dissociation—and this number N is Avogadro's constant. As is well known, the value of N has been determined for molecules with an astonishing degree of agreement by the most diverse methods. Thus Rutherford found $N = 62.10^{22}$ by counting the α particles given off by a given quantity of radium per second; and Dewar as well as Boltwood obtained identical values, 71.10^{22}, by a similar method.

A method of calculating N from the constants of heat radiation gave, according to a theory of Lorentz, $N = 62.10^{22}$. Lord Rayleigh determined the number N of molecules in a grammolecule from the diffusion of light from the sky and found N about 70.10^{22}.[10]

It would seem *a priori* perhaps doubtful whether or not the suspended particles of a colloidal solution behave like molecules. Perrin undertook to solve this problem. He points out that van't Hoff's law (for properly dilute solutions) is applicable, no

[7] Siebeck, *Pflüger's Archiv*, Vol. 148, p. 443, 1912.

[8] A. P. Mathews, *Am. Jour. Physiol.*, Vol. II., p. 455, 1904.

[9] *Journal of Exper. Zoology*, Vol. 13, p. 498, 1912.

[10] These data are taken from Arrhenius, "Theories of Solutions," New Haven, 1912, pp. 25 and 26.

matter whether molecules are small or large, light or heavy.

Can we not suppose under these circumstances that there is no limit of size for the particles which obey this law? Should it not be possible that even visible particles obey this law exactly, so that a granule, agitated by brownian movement, counts neither more nor less than an ordinary molecule in regard to the action of its shocks on a wall which blocks its progress? Or, in other words, may we not assume that the laws of perfect gases can be applied to emulsions made of visible granules.[11]

It is well known that Perrin determined the value of N from the measurement of the relative distribution of the suspended particles of an emulsion of mastix in a vertical column and found $N = 62.2.10^{22}$. Almost identical values were obtained by him by three other methods. This proves that as far as osmotic pressure is concerned the suspended particles of an emulsion behave exactly like the molecules of a gas.

Direct osmometric measurements of the osmotic pressure of proteins gave very low figures, as was to be expected from their high molecular weight. R. S. Lillie found 30 to 40 mm. Hg for a 2 per cent. solution of albumen,[12] Starling for the proteins of blood serum 40 mm. Hg.

The question may now be asked whether or not the proteins in solution have other qualities by which they attract water than their osmotic pressure? This question can easily be answered by using living cells as osmometers. We have seen that an m/8 NaCl or a .231m sugar solution are isotonic with a frog's muscle (gastrocnemius). The latter solutions have an osmotic pressure of 3933 mm. Hg. We have also seen that as an osmometer a frog's gastrocnemius may be considered accurate at the point of isotony within .03m sugar. Hence the osmotic pressure of the proteins of the blood is below the limit of sensitiveness of the muscle as an osmometer; or, in other words: if the attraction of water by blood is determined solely by the osmotic pressure of the blood that part of its total osmotic pressure which is furnished by the proteins must be negligible. This is indeed the case.

I asked my assistant, Dr. Beutner, to compare the change in weight of a frog's muscle in various solutions with and without proteins.[13]

CHANGE IN WEIGHT OF TWO GASTROCNEMII OF THE SAME FROG

	Muscle *a* in m/8 Ringer, Per Cent.	Muscle *b* in m/8 Ringer + 2 Per Cent. Gelatine. Per Cent.
After 1 hour	−1.6	−2.5
After 3 hours	−3.5	−4.3
After 8 hours	−3.2	−4.7
After 22 hours ...	−4.4	−3.8
After 29 hours ...	−4.2	−3.8

The differences in the two rows of figures are slight in comparison with the experimental errors and show that the addition of gelatine does not influence noticeably the absorption of water.

In a second experiment it was ascertained that in blood serum which was freed from the greater part of its salts by dialyzing it for 40 hours through parchment paper the muscle gains exactly as much in weight as it does in a NaCl solution of the same osmotic pressure. The serum had after dialyzation a freezing point depression of .03°, corresponding to a concentration of NaCl of about m/120.

CHANGE IN WEIGHT OF TWO GASTROCNEMII OF THE SAME FROG

	Muscle *a* in Dialyzed Serum, Per Cent.	Muscle *b* in m/120 Ringer, Per Cent.
After ½ hour ...	+22.3	+24.7
After 1 hour ...	+34.0	+38.0
After 2½ hours .	+51.0	+53.6

[11] Perrin, "Les Atomes," Paris, 1912, p. 128 ff.

[12] Lillie, *Am. Jour. of Physiol.*, Vol. 20, p. 197.

[13] R. Beutner, *Biochemische Zeitschr.*, Vol. 48, p. 217, 1913.

These two series of results may be considered as identical within the limits of error. They prove that proteins in solution attract water from the muscle solely according to their osmotic pressure and not according to any other real or assumed quality. They prove also that the salts and not the proteins of the blood determine the exchange of water with the tissues.

R. Lillie has shown that the addition of acid increases the osmotic pressure of a protein solution, but the increase is too small, even in dialyzed serum, to influence the velocity of water absorption, as the following figures show.

CHANGE IN WEIGHT OF TWO MUSCLES

	Muscle *a* in 50 c.c. Dialyzed Serum +1 c.c. N/10 HCl, Per Cent.	Muscle *b* in Dialyzed Serum without Acid, Per Cent.
After 1 hour ...	+ 33.0	+ 35.0
After 2 hours ..	+ 43.0	+ 46.0
After 4 hours ..	+ 52.0	+ 49.0
After 6 hours ..	+ 45.0	+ 43.0

I think all these experiments prove conclusively, (1) that colloidal solutions influence the absorption of water in the tissues solely by their osmotic pressure; and (2) that this osmotic pressure is so small in comparison with that of the salts in the liquids of the body that their influence is in general practically negligible.[14]

IV. PERMEABLE AND NON-PERMEABLE SOLUTES

The existence of semi-permeable walls which allow the water but not the solute to diffuse is the prerequisite for the manifestation of osmotic pressure. It is well known that Overton showed that dissolved substances which diffuse easily into the cell do not produce any osmotic effect. The permeability of cell walls for alkaloids can be directly demonstrated by their reaction with the tannic acid of the cells, and Overton showed that when added to an isotonic salt solution the alkaloids will not alter the water equilibrium. The substances which thus diffuse readily into the cells are alcohols, aldehydes and many other compounds which often show a relatively high degree of solubility in lipoids. The difference in the behavior of substances which are soluble in the cell wall (like alcohol) and non-soluble (like sugar) is illustrated by the following experiments by Overton.[15]

In 0.2 per cent. NaCl + 2.66 per cent. mannit (together equi-molecular with .7 per cent. NaCl) the gastrocnemius of a frog kept its weight for nine hours unaltered. In 0.2 per cent. NaCl + 2 per cent. methyl alcohol (approximately equi-molecular with a 1.6 per cent. NaCl solution), the muscle absorbed water as powerfully as in a pure 0.2 solution of NaCl. Only those substances which can not diffuse into the cell can assist in the exchange of water between tissues and the liquids of the body; exactly as Avogadro's law demands.

It is generally assumed that there is only one type of semi-permeable membranes, namely, those permeable for water, but not for neutral salts or sugars. This type is the most common. But there are at least two other types of semi-permeability. Some membranes are permeable for water as well as salts and sugars, but not for colloids. The fertilization membrane of the sea urchin egg (*Strongylocentrotus*

[14] The erroneous idea that the attraction of water by blood serum is determined by proteins may have originated through the arbitrary assumption that the phenomenon of imbibition found in solid colloids is retained by the colloids in solution. This reasoning is, however, not warranted, since it is possible that in solid colloids conditions for the absorption of water may exist which cease to exist when the colloid is dissolved.

[15] Overton, *Pflüger's Archiv*, Vol. 92, p. 115, 1902.

purpuratus) belongs to this type.[16] On the other hand, there are membranes which are neither permeable for salts nor for water. This type of membranes is represented by the eggs of *Fundulus*, and apparently *Fundulus* itself, and probably by a large number of other aquatic vertebrates.

All these membranes are, however, permeable for gases (O_2 and CO_2) dissolved in water.

V. THE APPARENT CONTRADICTION BETWEEN THE PHYSIOLOGICAL EFFICIENCY OF SALTS AND THE SEMI-PERMEABILITY OF CELL WALLS

We will now discuss a difficulty which the idea of impermeability of the cells for salts has to meet. In a pure NaCl solution the frog's muscle begins to twitch, while the addition of a little Ca inhibits this effect. It is difficult to assume that salts act without diffusing into the cell, and yet the phenomena of isotony are incomprehensible without the assumption of practical impermeability of the cell for salts and sugars. This difficulty is apparently relieved by the investigations of Loeb and Beutner[17] on the potential differences at the limit between living organs and the surrounding solution of electrolytes. If we form a cell of the type: solution of electrolyte (concentrated); living organ; solution of electrolyte (dilute), the dilute solution is positive towards the concentrated; and the more so the greater the dilution. This seems to be a fact for most living tissues. From this it follows that living tissues are reversible for kations. We were, moreover, able to show that the electromotive forces of such cells obey Nernst's law, according to which the E.M.F. varies with the logarithm of the concentration. But the most surprising fact we found was that the living cells are reversible in regard to practically any kation, while the potential differences heretofore observed by physicists at the limit of two phases were only reversible for one kation. These results are only intelligible on one of two assumptions: either the surface of all living organs contains already traces of all metals, which is not very probable; or traces of the electrolytes react with the surface of the living organ. If the latter is true we can understand that electrolytes can influence the life phenomena and yet produce the theoretically calculated osmotic pressure upon the walls of living organs.

The writer suggested thirteen years ago that chemical reactions occur between the electrolytes and certain parts of the "protoplasm"—proteins or fatty compounds—which result in the formation of ion or metal-proteins or soap-like compounds, and that these reactions explain the influence of the electrolytes upon muscular twitchings, heart beat, etc. It is well known that the action of salts like NaCl or $CaCl_2$ or KCl upon the heart beat or muscular twitchings is—within certain limits of concentration and time—perfectly reversible, and this reversibility is characteristic of this action. Such a complete reversibility of chemical reactions is intelligible if only traces of the salts enter into reaction with the substances contained in the living organ.

Beutner reached the conclusion on the basis of thermodynamical calculations that the potential differences observed by us at the junction of living organs and surrounding solution demand the assumption of a chemical reaction between traces of

[16] Loeb, *Roux's Archiv*, Vol. 26, p. 82, 1908.

[17] Loeb and Beutner, *Biochemische Zeitschr.*, Vol. 41, p. 1, 1912; Vol. 44, p. 303, 1912.

the electrolyte and the surface of the living organ.[18]

VI. THE ALTERATION OF THE SEMI-PERMEABILITY OF CELL WALLS BY ELECTROLYTES

Those who have worked with Pfeffer's semi-permeable cells report that it is very difficult to maintain cells in the state of ideal semi-permeability. It seems that the semi-permeability of living organs suffers also if they are exposed to solutions abnormal in concentration or constitution or both. The normal medium for the cells of our body is a liquid which contains NaCl, KCl and $CaCl_2$ in a proportion which is almost identical with the one in which those salts appear in the ocean. In such solutions, if their concentration is right, the cell walls may keep their specific semi-permeability as long as they live. If, however, the cells or organs are put into solutions of other salts, or of solutions with only one of the three salts just mentioned, the semi-permeability is lost sooner or later and death follows. The possible explanation is that the interactions between salts and surface of the living organ lead in this case to a modification of the physical qualities of the surface of the living organ.

In 1899 the writer found that the newly fertilized eggs of a marine fish, *Fundulus*, will develop normally in distilled water and the fish will hatch. If, however, the eggs are put into an m/2, or still better ⅝m, NaCl solution immediately after fertilization they will die without forming an embryo. If a small but definite amount of a salt with a bivalent metal is added to the NaCl solution the eggs will form embryos. The explanation of these facts is as follows:

If the newly fertilized eggs are put into a ⅝m NaCl solution the NaCl makes the egg membranes, which are naturally impregnable to salts, gradually permeable. NaCl enters the egg and the germ is killed. If a little Ca is added to the NaCl this modification of the membrane is inhibited, no NaCl enters the egg and the germ can live and develop. In distilled water the membrane remains also impermeable to salt (and to water) and the embryo likewise develops.[19]

The writer has recently published a series of experiments which furnish a proof for this assumption.[20] Only the general character of this proof can be indicated here. The eggs of *Fundulus* have a specific gravity of a little over 1.0580 (corresponding to 1⅛m NaCl solution). If such eggs several days after fertilization are put into a 3m solution of NaCl + KCl + $CaCl_2$ in the proportion in which these three salts occur in the sea-water, the eggs will float at the surface of the solution for four days or longer. Then they will shrink and fall to the bottom of the test tube. The membrane is impermeable to water and salts and remains so for a series of days even in a 3m solution of NaCl + KCl + $CaCl_2$. Finally it becomes permeable for water and to a lesser degree for salts and the eggs shrink and fall to the bottom. If, however, the eggs are put into a 3m solution of NaCl they will also float at first; but the increase in permeability and the shrinking begins in three hours. If we put the eggs into a solution of $CaCl_2$ from 1⅛m to 2½m they float at first, but the shrinking begins in 20 minutes and the eggs sink to the bottom. If we put the eggs into a mixture of 48 c.c. 3m NaCl + 2 c.c. 1⅛m $CaCl_2$ they will

[18] Beutner, *Biochem. Zeitschr.*, Vol. 47, p. 73, 1912.

[19] Loeb, SCIENCE, Vol. 34, p. 653, 1911. Reprinted in "Mechanistic Conception of Life," Chicago, 1912; *Pflüger's Archiv*, Vol. 107, p. 252, 1905.

[20] Loeb, *Biochemische Zeitschr.*, Vol. 47, p. 127, 1912.

float for three days, before they begin to shrink and fall to the bottom. This and similar experiments show that the specific semi-permeability of an animal membrane is influenced by the nature of the solutions to which it is exposed. In physiologically balanced solutions, *e. g.*, NaCl + KCl + $CaCl_2$ in the proportion in which these salts exist in the sea-water, this specific semi-permeability is preserved longest, if not permanently. In solutions of one salt only the permeability is as a rule increased as soon as the concentration of the salt in the solution exceeds a certain limit. This limit varies for different salts and varies also for the same salt in different animals. This is the reason why a pure NaCl solution becomes injurious more rapidly to one form of organism than to another. The reader will notice that in this field of phenomena the chemical nature of the solution is of primary importance.

This dependence of the preservation of semi-permeability upon the chemical nature of the surrounding solution suggests the possibility of a chemical interaction between cell walls and surrounding solution in which the chemical and physical properties of the semi-permeable wall are modified.

VII. THE DIFFERENCE IN THE MODE OF ABSORPTION OF WATER IN LIVING AND DEAD CELLS

We may conclude from the preceding data that the salts of the surrounding solution react chemically with the colloids of the surface of the cell and that the products thereby formed determine the degree of permeability or impermeability of the cell walls.

These changes vary with the chemical nature of the salt. In some solutions the permeability is preserved much longer than in others. Thus the muscle keeps its normal function much longer in a NaCl or a LiCl solution than in a solution of KCl or $CaCl_2$. As long as the muscle is irritable or even some time after it ceases to be irritable it obeys Avogadro's law in the solutions of pure salts. After 18 hours, however, the muscle is killed in pure isotonic solutions of KCl as well as of $CaCl_2$, while it is still alive in solutions of NaCl and LiCl. At that time it continues to obey the law of Avogadro in NaCl and LiCl, but no longer in KCl and $CaCl_2$.

CHANGE IN WEIGHT OF A GASTROCNEMIUS OF A FROG AFTER 18 HOURS IN SOLUTIONS EQUIMOLECULAR WITH m/8 NaCl [21]

	Per Cent.		Per Cent.		Per Cent.		Per Cent.
LiCl...	−1	NaCl..	+ 6	KCl..	+45.7	$CaCl_2$...	−20
LiBr...	−1	NaBr..	+ 7	KBr...	+41		
LiJ....	−3	NaJ...	+10	KJ.....	+45		

While the muscle undergoes no, or only slight, changes in weight in the isotonic solutions of Na and Li salts it absorbs a considerable amount of water in KCl, loses water in $CaCl_2$.

Overton, who later repeated and confirmed these results, explained them on the assumption that the normal muscle is permeable for KCl, but not for the other salts. In a pure KCl solution the salt gradually enters the muscle, whereby the osmotic pressure of the muscle is increased and the latter swells; while in a $CaCl_2$ solution the KCl naturally contained in the muscle leaves the muscle and the diminution of the number of molecules in the muscle makes the surrounding originally isotonic solution hypertonic for the muscle. One fails to see, on such an assumption, why the muscle does not also lose water in a NaCl solution. It has been demonstrated

[21] Loeb, *Pflüger's Archiv*, Vol. 75, p. 304, 1899; "Studies in General Physiology," Vol. II., p. 511, Chicago, 1906.

that the normal gastrocnemius of a frog contains little or no NaCl, but comparatively much KCl, while in the blood the reverse is the case. From this it has been plausibly argued that the NaCl of the blood can no more enter the muscle than can $CaCl_2$. One fails, however, to see how on this assumption the fact can be explained that in a pure NaCl or LiCl solution the muscle keeps its weight or gains slightly, while in $CaCl_2$ it loses considerably in weight, since in a pure NaCl solution the K-salts should leave the muscle as well as in a $CaCl_2$ solution.

In all hypertonic solutions the muscle loses water and the higher the concentration of the solution is the more water it loses. This is what should be expected according to Avogadro's law. But the writer noticed that if the muscles remain in the hypertonic solution they begin after a certain time to absorb water and the higher the concentration the sooner, so that finally the muscle begins to swell even in a grammolecular solution of NaCl!

This paradoxical behavior finds its explanation in the writer's observations on *Fundulus* eggs, which show that the impermeability of the membrane for salts and sugars is destroyed the more rapidly the higher the concentration of a solution. As soon as this impermeability is destroyed the cells no longer follow Avogadro's law, but show a behavior which is comparable to that of a piece of solid gelatine, *i. e.*, water is absorbed not by osmotic forces but by "imbibition." The degree of imbibition varies with the nature of the surrounding salt and on this assumption the writer explained the differences of behavior of dead muscle in KCl and $CaCl_2$ solutions.[22]

[22] Loeb, *l. c.*

VIII. THE ANTAGONISM BETWEEN ACIDS AND SALTS

The influence of the chemical character of the surrounding solutions upon imbibition in the dead muscle is well illustrated by the following observations:

The writer showed sixteen years ago that the muscle absorbs water from an m/8 solution of NaCl if HCl (or any other acid) is added.[23] In this case the law of Avogadro-van't Hoff is apparently violated. It was pointed out by Overton that in this case the acid destroys the semipermeability of the muscle and that the subsequent absorption of water was a mere phenomenon of imbibition. It had been shown previously that the swelling of a solid plate of gelatine in water is increased if acid is added.

In a subsequent paper it was shown by the writer that there exists a curious antagonism between salts and acids. While a muscle swells in an m/8 NaCl solution if the latter is rendered acid, it does not swell, or it may be even dehydrated in an acid solution when the concentration of the NaCl in the solution is sufficiently raised; notwithstanding the fact that in the highly concentrated *neutral* NaCl solution the muscle will finally absorb water.

The following table illustrates this:

Neutral NaCl		m/110 HCl in NaCl	
Concentration of NaCl, Per Cent.	Increase in Weight in 18 Hours, Per Cent.	Concentration of NaCl, Per Cent.	Increase in Weight, Per Cent.
4.9	+6	4.9	—36
1.22	—2	1.22	+22.2
0.7	+7	0.7	+40

While the muscle gains in weight in eighteen hours in a neutral 4.9 per cent.

[23] Loeb, *Pflüger's Archiv*, Vol. 69, p. 1, 1897; Vol. 71, p. 457, 1898. "Studies in General Physiology," Vol. II., pp. 450 and 501, Chicago, 1906.

NaCl solution, it loses considerably in an m/110 acid 4.9 per cent. NaCl solution.[24]

The writer also pointed out that the chemical character of the salt was of great influence in this phenomenon. While it required a high concentration of NaCl and of acid to cause a dehydration, the same was accomplished by a much weaker solution of K_2SO_4. In a neutral isotonic solution of K_2SO_4 the muscle lost 4 per cent. in eighteen hours, but when 10 c.c. m/10 HCl were added to 100 c.c. isotonic K_2SO_4 solution the muscle lost 22 per cent. of its weight! The concentration of K_2SO_4 required to inhibit the swelling effect of the acid is therefore much smaller than that of NaCl.[25]

When a muscle is put into a .04 solution of Na_2SO_4 which is rendered m/200 acid through the addition of H_2SO_4 the muscle first absorbs water and later is dehydrated, as the following experiment by Beutner[26] shows:

CHANGE IN WEIGHT OF MUSCLE IN .04m Na_2SO_4 — N/200 H_2SO_4

1 hour	+ 9.9
3 hours	+ 12.3
6 hours	+ 1.8
24 hours	— 19.3
32 hours	— 25.2
96 hours	— 31.2

The interpretation of this result offers no difficulty. As Beutner pointed out, the muscle obeys the law of van't Hoff, as long as it is alive, or more correctly, as long as the semi-permeability of its membrane is preserved. Since a .04m solution of Na_2SO_4 is hypotonic, the muscle must absorb water in such a solution. As soon as the semi-permeability of the muscle is lost and the acid diffuses into the muscle it behaves altogether differently, namely, like a piece of gelatine. Proctor has shown that solid gelatine swells in a salt solution as well as in an acid solution, while it is dehydrated in a combination of both; and the same is true for the dead muscle.

IX. INTERNAL CHANGES IN THE MUSCLE

Miss Cooke showed that the fatigued muscle of a frog is no longer isotonic with an m/8 solution of NaCl, but with a 3m/16 solution. The fatigue has, therefore increased the osmotic pressure of the muscle.[27] The writer suggested that in this case lactic acid was formed and that this lactic acid was the cause of the absorption of water by the muscle in an isotonic solution.[28] The lactic acid might act as a catalyzer in certain reactions, whereby the osmotic pressure would be raised in the muscle. Others assume that some colloid in the muscle is caused to swell by the acid. This could only refer to some solid colloid. But it is difficult to understand how this could force the muscle to absorb more water. Proctor[29] has shown that solid colloids absorb not only *water*, but also *salts* (even in the presence of acid); if this be the case the swelling of solid colloids inside the muscle can only increase the osmotic pressure of the liquids contained inside the muscle cells, if relatively more water is absorbed than salt. Since no quantitative data are available on this point, it is useless to argue the question.

[24] Loeb, *Pflüger's Archiv*, Vol. 75, p. 302, 1899. Reprinted in "Studies in General Physiology," Vol. II., p. 516, 1906.

[25] Loeb, *Pflüger's Archiv*, Vol. 75, p. 303, 1899; "Studies in General Physiology," Vol. II., p. 514.

[26] Beutner, *Biochem. Zeitschr*, Vol. 39, p. 280, 1912.

[27] In order to avoid misunderstandings it should be said that the fatigued muscle obeys Avogadro's law, only its point of isotony is increased.

[28] Loeb, *Pflüger's Archiv*, Vol. 71, p. 466, 1898.

[29] Proctor, "Kolloidchemische Beihefte," Vol. II., p. 262, 1911.

CONCLUSION

I believe the facts mentioned in this address show that those animal cells or organs which lend themselves to exact measurements of osmotic changes obey the law of Avogadro-van't Hoff, as long as they are normal or alive: *i. e.*, they neither absorb nor lose water if put into solutions of any kinds of sugar or neutral salts which are equi-molecular with the blood; that they absorb water in solutions of lower osmotic pressure, lose water in solutions of higher osmotic pressure. If the law of Avogadro and van't Hoff is correct (which nobody doubts), this behavior of the tissues is the expression of the applicability of this law to the exchange of water between tissues and liquids of the body.

It does not often happen in biology that we are able to reduce life phenomena to a fundamental physico-chemical law to such an extent that we can not only predict the results qualitatively, but also quantitatively, as is the case in the application of Avogadro's law to the exchange of water between tissues and the liquids of the body.

If anybody wishes to supplant the law of Avogadro he must be able to offer a theory which allows a still closer approximation between calculated and observed results than is the case in the experiments on the absorption of water by animal cells or tissues. No such theory has thus far been offered.

JACQUES LOEB
THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH

THE SPREAD OF THE BROWN-TAIL AND GYPSY MOTH

FOR several years Massachusetts has been spending large sums of money in fighting the brown-tail and gipsy moths. These insects have spread westward in their devastating course and are now recorded from a point not far distant from the eastern boundary of New York. In February a conference was called in Boston by the state forester of Massachusetts for the purpose of bringing together not only those actually engaged in the fight with the gipsy and brown-tail moths, but those who are sure to be concerned in the near future. The New York State College of Forestry at Syracuse University is investigating the work of these insects and Dr. M. W. Blackman, forest entomologist of the college, was its representative in the conference in Boston and is ready to take up the fight against these insects when they appear in this state.

Interesting facts were brought out at this conference as to the spread of the gipsy moth. It is very certain that New York and other states about Massachusetts will soon be reached by these destructive insects and that unless more effective means are taken they will destroy not only forest trees but shade and ornamental trees over large sections of the state. As shade tree pests these insects can be controlled by spraying and destroying egg clusters, but these methods are used only at considerable expense and must be continued indefinitely. It seems probable that as soon as the parasites and diseases introduced from abroad which work upon and destroy these insects have become fairly established that they will aid man greatly against future serious outbreaks.

The gipsy moth problem of the future in the state of New York is a forestry problem, as the insect can not be fought in the forest by spraying but must be controlled and eventually eliminated by proper methods of forest management. Certain trees, such as the oak, willow and birch, are apparently more favorable and often seem necessary for the development of the caterpillars of the moths. Methods of forest management can be used which will remove these trees from the forest and thus destroy the most favored food of the pests. With these methods of proper forest management must go strict quarantine against lumber, cordwood and nursery products shipped in from infested areas. Some effort

has been made to establish a "dead line" to prevent further spread of the insect. A zone of timber consisting largely of white pine and other evergreens is selected and all hardwoods or broad-leaf growth removed. As the insects are unable to complete their life history on the pines, they are checked and it may be possible to prevent their spreading northward into the Adirondacks, or into the Catskills, through the maintenance of such zones of coniferous growth. In the caterpillar stage the two moths do the greatest damage and the greatest spread of the insect occurs at this time. They are often blown long distances by the wind or carried by automobiles and other vehicles and much can be done in preventing this kind of distribution by keeping the roadside districts free of the caterpillars through spraying and the removal of their favored food plants.

The outbreak of the gipsy moth in this state in the summer of 1912 was not extensive and by prompt measures, such as the removal of infested trees, spraying, etc., the colony was destroyed. It is entirely possible, however, that there may be other well established colonies in outlying districts near the Catskills or Adirondacks of which there is no official knowledge. The state in the prosecution of its forestry work should make thorough investigations, especially along the eastern border in sections where there is the greater danger of the incoming of the caterpillar and thus prevent its doing the tremendous damage which it has done in Massachusetts.

THE NEW GEOLOGICAL SURVEY BUILDING

After a campaign lasting 26 years the United States Geological Survey has received generous recognition at the hands of congress in the authorization of an expenditure of $2,596,000 for the construction of a fireproof building "of modern office-building type of architecture." With this sum it is proposed to erect a building on ground already owned by the government which shall accommodate, besides the Geological Survey, the Reclamation Service, the Indian Office and the Bureau of Mines, all bureaus of the Interior Department whose work is closely related to that of the Survey and among all of which there is more or less constant cooperation. The public buildings law, which carries the Survey item, authorizes an immediate appropriation of $596,000, the balance to be appropriated as needed in construction. Plans can thus go forward at once for the construction of the new building. For the needs of the Survey and the other bureaus mentioned an up-to-date, conveniently arranged, and well-lighted building is of especial importance. Too many of the civil employees at Washington work in part or exclusively by artificial light, in quarters that may be compared to dungeons, a condition which is suggestive of medieval times, when the first requirement of castles was walls thick enough to resist the attacks of battering rams and catapults, or of the still more ancient period when huge, ornate pillars and columns were the fashion, regardless of the arrangements with respect to light and convenience on the inside of the building. The innovation of providing a structure of the modern office type for government "workshops" in which a maximum of the best work is the first consideration, such as will occupy the new building, will be welcomed.

Mr. Alfred H. Brooks, of the Alaska Division, Mr. Sledge Tatum, of the Topographic Branch, and Mr. Herman Stabler, of the Water Resources Branch, of the Geological Survey, have been appointed an advisory committee to assist the director in regard to the plans for the new building.

SCIENTIFIC NOTES AND NEWS

For the meeting of the British Association, which will take place in Birmingham on September 10–17 next, under the presidency of Sir Oliver Lodge, F.R.S., the following sectional presidents have been appointed: A (mathematics and physics), Dr. H. F. Baker, F.R.S.; B (chemistry), Professor W. P. Wynne, F.R.S.; C (geology), Professor E. J. Garwood; D (zoology), Dr. H. F. Gadow, F.R.S.; E (geography), Professor H. N. Dickson; F (economics), Rev. P. H. Wicksteed; G (engineering), J. A. F. Aspinall, M.Eng.; H (an-

thropology), Sir Richard Temple, Bart., C.I.E.; I (physiology), Professor F. Gowland Hopkins, F.R.S.; K (botany), Miss Ethel Sargant, F.L.S.; L (education), Principal E. H. Griffiths, F.R.S.; M (agriculture), Professor T. B. Wood.

THE following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the society: Professor V. H. Blackman, Dr. William Bulloch, Mr. D. L. Chapman, Professor W. E. Dalby, Dr. T. R. Elliott, Professor J. C. Fields, Dr. J. S. Flett, Professor J. P. Hill, Mr. A. R. Hinks, Professor F. Keeble, Professor A. Keith, Dr. K. Lucas, Professor O. W. Richardson, Dr. W. Bosenhain, and Mr. G. W. Walker.

THE university faculty of Cornell University passed on March 14 the following resolution:

WHEREAS Professor Willard C. Fisher, a distinguished alumnus and former fellow of the university, has been dismissed from the chair of economics and social science at Wesleyan University on grounds stated in the letters of January 27, 1913, exchanged between the president of Wesleyan University and Professor Fisher; therefore, *Resolved*, that the faculty of Cornell University extend to Professor Fisher greetings and assurance of regard, with the message that his *alma mater* still seeks to maintain and extend the spirit of liberality, toleration and loyalty to truth, illustrated by the principles and l'ves of its founders, Ezra Cornell and Andrew D. White.

ON May 3 the Duke of Northumberland will be installed as chancellor of Durham University in succession to the late dean of Durham. The following are among the honorary degrees to be conferred: D.C.L., Lord Rayleigh; D.Sc., Sir Archibald Geikie, P.R.S., Sir J. J. Thomson, F.R.S., Sir William Crookes, F.R.S., Sir William Ramsay, F.R.S., Sir J. A. Ewing, F.R.S., Sir T. C. Allbutt, and Professor E. B. Poulton, F.R.S.

THE Harris lecture committee of Northwestern University has announced that the Norman Waite Harris lectures for 1913–14 will be delivered by Dr. Edwin Grant Conklin, professor of zoology at Princeton University. The general subject of his lectures will be heredity and eugenics.

DR. LLOYD MORGAN, F.R.S., has been appointed Herbert Spencer lecturer for 1913 at the University of Oxford.

DR. ERNST MACH, professor of physics at Vienna, celebrated his seventy-fifth birthday on February 18.

THE trustees of the Peabody Museum, Salem, Mass., have granted Professor Edward S. Morse a year's leave of absence from the directorship with full salary, in order that he may complete his revision of the New England Mollusca and prepare for publication his Japanese journals.

DR. OSHAR BOLZA, honorary professor of mathematics in the University of Freiburg, who was for eighteen years actively associated with the department of mathematics in the University of Chicago and who is still nonresident professor in that department, will give courses during the summer quarter of the present year.

PROFESSOR CHARLES LANE POOR, of Columbia University, has been given leave of absence for next year. Professor Edward Kasner will have leave of absence during the second half year.

AT the recent meeting of the American Breeders' Association, Dr. David Fairchild, of Washington, was elected president, and Professor W. E. Castle, of Harvard University, vice-president.

OFFICERS of the Association of American Medical Colleges elected at Chicago, on February 26, are: *President,* E. P. Lyon, St. Louis University; *Vice-president,* F. F. Wesbrook, University of Minnesota; *Secretary-treasurer,* F. C. Zapple, University of Illinois.

EDWARD W. BERRY, of the Johns Hopkins University, has been elected a member of the Société Géologique de France.

DR. S. W. STRATTON, director of the United States Bureau of Standards, Washington, D. C., has been elected a member of the council of the Underwriters' Laboratories, Chicago, Ill. The council is made up of twenty-

two leading engineers and experts of the United States and Canada, who serve without recompense and supervise the technical work of the institution.

Arthur H. Blanchard, M. Am. Soc. C. E., professor of highway engineering, Columbia University, has been appointed by Governor Sulzer a member of the advisory commission on highways for the state of New York.

Mr. Andrew H. Palmer, A.B. (Minnesota, '08), A.M. (Harvard, '09), formerly research assistant at Blue Hill Meteorological Observatory, has been appointed magnetic observer in the department of terrestrial magnetism, Carnegie Institution of Washington.

The Nantucket Maria Mitchell astronomical fellowship of $1,000 annually has been awarded a second time to Miss Margaret Harwood, A.B. (Radcliffe, '07). Her residence at the Nantucket Observatory is for six months, the remainder of the year is spent in a larger observatory of her own choice. She has elected to continue her researches at the Harvard College Observatory during this semester.

Associate Professor Herbert E. Slaught, of the department of mathematics in the University of Chicago, has recently become the managing editor of the *American Mathematical Monthly*—a journal for teachers of mathematics in the collegiate and advanced secondary fields.

On the suggestion of the high commissioner for Cyprus, Sir Ronald Ross is this month visiting the island to investigate the causes of the prevalence of malarial fever.

The Costa Rica-Panama Boundary Commission, of which Professor John F. Hayford, of Northwestern University College of Engineering, is chairman, is now in session at Northwestern University, compiling the results of the survey and investigations made a little over a year ago to settle the boundary dispute between the two countries. The commission was appointed by Chief Justice White, and the case will be argued before him as soon as the maps and information are complete. Director Hayford is also engaged in a commission for the Carnegie Institution, the result of which is to determine the amount of evaporation of the five great lakes.

The geological museum of Harvard University is sending G. C. Curtis to Hawaii to collect data for a naturalistic model of Kilauea. Kilauea crater lies within the proposed, and recently surveyed, U. S. National Volcano Park, where the Massachusetts Institute of Technology has recently erected an observatory. Mr. Curtis is the first American geologist to specialize in land relief and has during the past fifteen years brought a new motive and standard into American work. The model of Kilauea will be 12 feet long on the scale of 1:1500, and Museum Curator Sayles expects it to be unique in the contributions to the study of volcanoes.

Professor Joseph S. Ames, director of the physical laboratory, Johns Hopkins University, delivered an address on "Modern Views of the Structure of Matter" before the Science Club of the University of Wisconsin on March 4, 1913.

Dr. George A. Dorsey, curator of anthropology in the Field Museum of Natural History, lectured before the Geographical Society of Chicago on March 14, his subject being "An Ethnologist Abroad."

Professor C. C. Thomas, of the University of Wisconsin, lectured on March 6 at the University of Illinois on the subject "Marine Engines." The lecture was one of a series of exchange lectures arranged between the two universities.

Dr. F. K. Cameron, of the bureau of soils, U. S. Department of Agriculture, lectured before the Phi Lambda Upsilon Society at Columbia University on "The Solution of the Potash Problem in America," on March 6.

G. Willis Moore, chief of the Federal Weather Bureau, lectured at Oberlin College on March 12, on "The Story of the Air."

Sir Rickman J. Godlee, president of the Royal College of Surgeons, gave, on March 13, the foundation oration before the University College Union Society on "Lister and his Work."

IT is stated in *Nature* that an exhibition of works by the late Mr. Thomas Woolner, R.A., has been opened at his studios. The exhibits include a number of objects of interest to men of science, among them being plaster busts of Charles Darwin, Huxley and Richard Quain, bronze medallions of Darwin and Sir Joseph Hooker, a colossal head, in plaster, of Captain Cook, and a bronze medal representing science and research. Any works not disposed of during the exhibition will be sold in the studio by auction.

MR. WILBUR WRIGHT bequeathed $50,000 to each of his brothers, Rauchlin Wright and Loring Wright, and to his sister, Katharine Wright. His other property he left to his brother, Orville Wright, "who has been associated with me in all the hopes and labors both of my childhood and manhood, and who will, I am sure, use the property in very much the same manner as we would use it together, in case we should both survive to old age; and for this reason I make no specific bequest to charity."

PROFESSOR ADAM SEDGWICK, F.R.S., formerly professor of zoology at the University of Cambridge, and since 1909 in the Imperial College of Science, London, has died at the age of fifty-seven years.

SIR WILLIAM ARROL, the distinguished British bridge builder, died on February 20, at the age of seventy-four years.

MR. GEORGE MATTHEY, F.R.S., who, while actively engaged in commercial work, made experiments in scientific metallurgy, died on February 14, aged eight-seven years.

DR. M. M. MCHARDY, late professor of ophthalmology in King's College, London, inventor of the registering perimeter which bears his name, died on February 8, at the age of sixty years.

PROFESSOR W. TAIT, in charge of chemistry in the civil engineering college at Sibpur, near Calcutta, died on February 19.

M. ALFRED MAURICE PICARD, the eminent French engineer, member of the Paris Academy of Sciences, died on March 8, aged sixty-nine years.

THE death is announced of Professor William H. Lennon, for forty-two years head of the department of science in the Brockport State Normal School, New York.

PHI LAMBDA UPSILON, the honorary chemical society, will hold its biennial convention at Milwaukee, Wis., March 24 and 25, just preceding the meeting of the American Chemical Society. The headquarters for the convention will be the Hotel Pfister.

THE regents of the University of Wisconsin have voted to extend an invitation to the Association of American Agricultural Colleges and Experiment Stations to hold a four-week graduate school in agriculture and home economics at the university, in July, 1914.

THE German Association of Engineers is making preparations for the reception of the American Society of Mechanical Engineers, which will hold its annual meeting this year in Leipzig. The Americans will arrive at Hamburg on June 19. Following the meeting they will make a fortnight's tour of Germany.

THE twenty-second session of the Marine Biological Laboratory of Stanford University, will begin Tuesday, May 27, 1913. The regular course of intruction will continue six weeks, closing July 8. Investigators and students working without instruction may make arrangements to continue their work through the summer. The laboratory, which is at Pacific Grove, will be under the general supervision of Professor F. M. McFarland, instructor in charge.

A CONFERENCE on the Conservation of Human Life will be held at Reed College, Portland, Oregon, on May 9, 10 and 11, 1913. There will be lectures, discussions, exhibits, moving pictures, out-of-door games and meetings of societies. All organizations and individuals devoted to human welfare are invited to take part in the conference. Fifteen rooms are available for the exhibits and fifteen rooms for meetings of such organizations. Three assembly rooms are equipped for stereopticon exhibitions. The following topics suggest the

scope of the conference: Organized efforts to abolish war, venereal diseases and child labor; to obtain pure foods, to prevent tuberculosis, to promote temperance, to improve conditions of labor, to safeguard men at sea and on railroads, to improve country life conditions, to better the living conditions of prisoners, juvenile offenders and other defectives, to prevent contagion, to curb occupational diseases, to solve the housing problems of cities, and the health problems of immigration, to promote school hygiene, playgrounds and recreation centers.

The coroner of Cook County, with headquarters in Chicago, is about to establish a chemical laboratory, primarily for toxicological chemistry. The salary of the chemist in charge will be $2,500 per annum, and there will be one assistant. The work will be directed by an advisory committee consisting of Hon. Harry Olson, chief justice, Municipal Courts of Chicago; Professor John H. Long, professor of chemistry, Northwestern University Medical School; John A. Wesener, M.D., Columbus Memorial Laboratory; Ludvig Hektoen, M.D., director, Memorial Institute for Infectious Diseases; Professor Walter S. Harnes, professor of chemistry and toxicology in the University of Chicago and Rush Medical College. Applications may be sent to Peter M. Hoffman, coroner, Room 500, County Building, Chicago, Illinois.

The Field Museum of Natural History announces its thirty-eighth Free Lecture Course as follows:

March 1—"A Look into South America," Professor Rollin D. Salisbury, the University of Chicago.

March 8—"Fossil Collecting," Mr. A. W. Slocom, assistant curator, Division of Invertebrate Paleontology.

March 15—"Cultural and Somatic Evidences of Man's Antiquity," Professor George Grant MacCurdy, Yale University.

March 22—"Spain: Country and People," Mr. Arthur Stanley Riggs, New York.

March 29—"Newfoundland," Professor M. L. Fernald, Harvard University.

April 5—"Wild Flowers of the Chicago Region," Dr. C. F. Millspaugh, curator, Department of Botany.

April 12—"Crossing the Andes of Northern Peru," Mr. W. H. Osgood, assistant curator of mammalogy and ornithology.

April 19—"Logging California Redwoods," Mr. Huron H. Smith, assistant curator, Division of Dendrology.

April 26—"Religious and Artistic Thought in China," Dr. Berthold Laufer, associate curator of Asiatic ethnology.

Lincoln Hall at the University of Illinois was formally dedicated "to the study of the humanities, in memory of Abraham Lincoln, and in the name of the people of Illinois" on Lincoln's birthday, February 12. Representatives from many American educational institutions were present. Addresses on the importance to the commonwealth of adequate provisions for the study of the humanities were made by Professor Bliss Perry, of Harvard University; Dean Frederick J. C. Woodbridge, professor of philosophy at Columbia University, and by Dr. Albert Shaw, editor of the *Review of Reviews*. Bishop Wm. F. McDowell, of Chicago, conducted the ceremony of dedication, and addresses were made by the governor of the state, the president of the board of trustees, the state architect and the president of the university. Dr. Hugo Black, of Union Seminary, New York, spoke on "How Lincoln Appeared to a Scotchman." The sum of two hundred and fifty thousand dollars was appropriated at the session of the Illinois legislature beginning in January, 1909, the hundredth anniversary of Lincoln's birth, for a building to be dedicated to the study of humanities. It was decided to make this building a memorial to Abraham Lincoln, the first citizen of Illinois to be elected president of the United States, the signer of the bill which made the state university possible and the consistent and persevering friend of higher education in state and nation. The scheme of decoration includes a series of

memorial panels, tablets, medallions, inscriptions, etc., relating to Lincoln and his times, so that students and professors at work in this building, or even passing along the walks about it, should be in daily and hourly remembrance of what this man and his coworkers did for the American people. Quarters are provided on the first floor for the classics and for the philosophical group or department; on the second floor, for English and modern languages; and on the third floor, for the social science group, comprising history, economics, politics and sociology. The north and south wings of the fourth floor are set apart for two museums. The museum of classical archeology and art comprises collections designed to show especially the influence on our American life of the fine arts of the Greeks and Romans, particularly sculpture and other forms of antiquities, by means of casts, photographs and original articles. The second museum, the museum of European culture, occupies the north wing of the building and contains much illustrative material. The museum of classic art was opened on November 8. Professor George Henry Chase, of Harvard University, delivered the dedicatory address. The museum of European culture was opened February 6, at which time Professor Kuno Franke, of Harvard University, delivered two addresses.

UNIVERSITY AND EDUCATIONAL NEWS

JAPANESE graduates of Harvard University have subscribed a fund of $20,000 as the foundation for a lectureship in the department of philosophy to provide for the teaching of Japanese and other Oriental systems of philosophy.

ON March 6, the University of Illinois opened a medical college in Chicago. The property formerly belonging to the College of Physicians was definitely presented by the alumni to the university. It is valued at $500,000 with an indebtedness of $245,000. Twice the state legislature by a large majority has appropriated money for a medical school in connection with the university. The first time the bill was vetoed by the governor because of lack of funds, the second time the bill was thrown out on a technicality. At the opening exercises addresses were given by Dr. Frank Billings, dean of Rush Medical College, by Dr. A. R. Edwards, dean of Northwestern University Medical School, by Dr. Arthur Dean Bevan, chairman of council on Medical Education, American Medical Association; by President E. J. James, of the University of Illinois; by Dean W. E. Quine and others.

THE plans for transforming the scientific institutes at Frankfort-on-Main into a university have now been sanctioned by the Prussian ministry of public instruction. The capital subscribed is nearly $2,000,000.

DR. A. R. FORSYTH, F.R.S., has been appointed chief professor of mathematics at the Imperial College of Science and Technology, London.

MR. AUGUSTINE HENRY, M.A., reader in forestry at Cambridge, has been appointed professor of forestry in the Royal College of Science for Ireland. The chair of forestry at the college has but recently been established.

MR. ROBERT B. BOURDILLON, lecturer in chemistry at Balliol College, Oxford, has been elected to a fellowship in chemistry on the teaching staff of University College.

AT Sheffield University Miss Sophia M. V. Witts, M.D. (London), has been appointed to the newly-instituted post of "lady tutor in anatomy."

THE following appointments have been made in the department of public health at King's College, London: Dr. E. W. Routley, medical officer of health, Aldershot, to be lecturer in sanitary law and administration; Colonel W. G. King, late sanitary commissioner in the Madras Presidency, to be lecturer in applied hygiene in the tropics; Dr. W. F. Roach, to be lecturer on school hygiene for medical officers.

DISCUSSION AND CORRESPONDENCE

THE YELLOWSTONE

To the Editor of Science: In a recent lecture before the students of Lehigh University describing a camping trip through the Wind River Mountains and through the Yellowstone Park during the summer of 1911, I exhibited a working model of a geyser which erupted about forty times per hour, and a working model of the curious Handkerchief Pool which is located in the Upper Geyser Basin about a mile west and north of Old Faithful Inn. Perhaps some of the readers of Science may be interested in the model of the Handkerchief Pool and the explanation of its action.

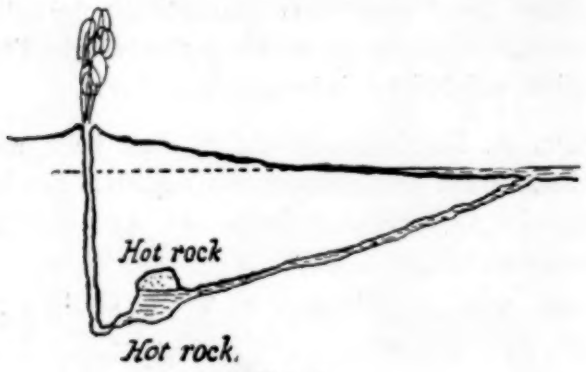

Fig. 1.

The eruptive action of a geyser is probably due, as Bunsen suggested, to the heating of the water at the bottom of a deep hole to a temperature much above 100° C., and the consequent violent boiling of this over-heated water when the pressure is suddenly lowered by the blowing out of the water in the upper part of the hole. A small working model of the geyser can not conveniently be made on this principle. The principle of operation of the model geyser I used in my lecture is shown in Fig. 1, and the actual apparatus is shown in Fig. 2.

The principle of operation of the Handkerchief Pool is shown in Fig. 3. Hot water is pushed in a sudden pulse through a channel and through the small throat *TT* into a shallow pool *PP*, and the condensation of the driving steam causes a sudden backward suction through the throat. This action is repeated several times per minute, and the hot water in the shallow pool being cooled, flows downwards at the edges of the pool and towards the throat as indicated by the arrows. Placing the handkerchief at the edge of this

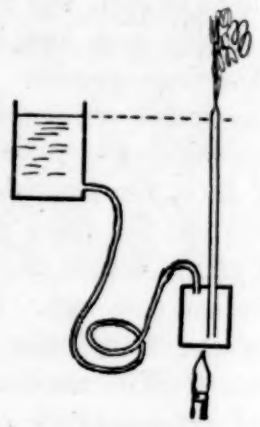

Fig. 2.

pool it is carried towards the throat by the downward flow of cool water, and when it comes near the throat it is suddenly sucked out of sight into the chamber *C*. The impres-

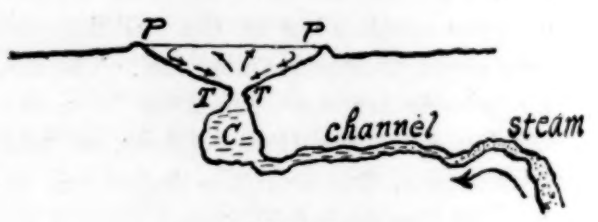

Fig. 3.

sion is that one will never recover his handkerchief, but in the course of about half a minute the handkerchief is thrown violently out of *C* by an upward surge of hot water. If the handkerchief is left in the pool this behavior is repeated over and over again.

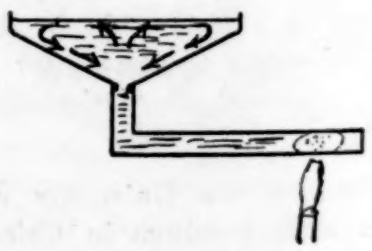

Fig. 4. Working Model of Handkerchief Pool.

In all probability the numerous small hot springs in the Geyser Basin and perhaps also at Mammoth Hot Springs come from jets of

steam which are condensed near the surface of the rock and the condensed water collects in small pools from which it flows in a small stream. The hot springs at the lower levels may be genuine streams of water flowing from great depths, but it is inconceivable that they should originate in one connected body or stream of water.

Tourists who camp in the Park are called "sagebrushers," and if you wish to excite the indignation of a "sagebrusher" talk to him about Yellowstone Park bears! One or two bears feeding at each hotel garbage dump would be sufficient for tourists; but at present bears congregate at the various hotel garbage dumps to the number of fifteen or twenty at a time, and the cleaning out of sagebrushers' camps by marauding bears is a nightly occurrence. The one all-absorbing topic of conversation among sagebrushers is marauding bears; and it is by no means a joke, for three or four sagebrushers are killed nearly every summer in attempting to drive bears out of their camps! The Yellowstone Park bears are an unmitigated and intolerable nuisance, and nine tenths of them should be killed at once. The only alternative is for the Park authorities to establish a vigilant all-night watch around every camping ground.

One of the points of interest at Mammoth Hot Springs is a grotto, a cavity in the hot-springs formation, and tourists are taken into this grotto in parties of twenty or thirty at a time. Only one hundred yards or so from the grotto is an opening through which carbon dioxide issues, filling a small depression at the bottom of which two or three dead birds are usually seen. If a crevice should be opened up from the grotto to any of the old hot-water channels, the grotto would in all probability be filled with carbon dioxide, and the next party of tourists would be left at the bottom of the grotto like the birds in the little valley near by. It would be wise on the part of the park management to provide for a test of the air of the grotto every morning during the tourist season. If this is not done a disaster is likely to occur at any time.

At Mammoth Hot Springs Hotel I wished to purchase a number of large colored views and I naturally went to the "official photographer of the park." The next day, however, I found a better grade of pictures for sale at an outside place and at a cheaper price, and to my disgust I found that the colored views I had purchased from the official photographer were of foreign manufacture, whereas the cheaper and better ones which were sold by the unofficial photographer were of American manufacture! Surely the position of official photographer should be done away with in the Yellowstone Park. Very certainly it is not right for the public to be led by the term "official photographer" to purchase foreign-made colored views which are more expensive than American-made views and at the same time distinctly inferior.

Any one who has traveled through the region to the south and east of the Yellowstone Park must realize what a splendid game preserve we could have if the Yellowstone Park were extended to the east so as to include the Absaroka Mountains and to the south so as to include Jackson's Hole and Teton Mountains and Gros Ventre Mountains. The private holdings of land in Jackson's Hole could be purchased for a very moderate sum and the entire surrounding mountain region is already included in the National Forest Reserves. It would be a very easy matter for the national government to greatly extend the boundaries of the Yellowstone Park and create what would be perhaps the most magnificent asylum for wild animals in the whole world.

W. S. FRANKLIN

ALLEGHANY VALLEY EROSION

TO THE EDITOR OF SCIENCE: In the recent issue of the *Bulletin* of the Geological Society of America, Vol. XXIII., p. 295, is the paper of G. F. Wright on "Postglacial Erosion and Oxidation." In the summary of the discussion which followed, the reporter states that Mr. Leverett offered as disproof of the conclusions of Professor Wright the "great erosion in the upper Alleghany region which occurred between the deposition of the old drift and of the young or Wisconsin drift."

Here is a general statement that there is an "old" and a "young" drift in the "upper Alleghany region," and that a "great erosion" occurred between their deposition. The generality of the statement would lead one to infer that the erosion was general throughout the region, and that this fact was generally received, as well as that there was such a distinction between the "old" and "young" drifts that they could be readily differentiated everywhere by physical characteristics.

In discussing this statement we must first ascertain what Mr. Leverett considers "the upper Alleghany region," as the river is a long one. Happily we have in the map compiled by Mr. Alden for the Geological Survey a very plain demarkation of areas variously estimated by Mr. Leverett. In the above discussion he uses the term "old" drift, referring to the first or Kansan advance. Combining this statement with the areas of the map we arrive at the conclusion that the uppermost portions of the Alleghany region to which he can possibly refer begin in the immediate vicinity of Warren, Pennsylvania, which is about 100 miles from the source of the river, as above that place the river is marked as flowing through areas not reached by Kansan ice. The terms Kansan and Wisconsin are used to define alleged earlier and later phases of glaciation separated by a long interval. We will, therefore, discuss the conditions of this system from Warren southward; but as there is no method of estimating where Mr. Leverett's term "upper" ends, we will continue our discussion to and below Parker, which is half way between Warren and Pittsburgh.

After Lewis and Wright published the volume of the Second Geological Survey of Pennsylvania delimiting the "terminal moraine," Carll, in his report of the Warren region, called attention about thirty-five years ago to the preglacial channel of the Conewango now deeply buried throughout in drift which rose near Kane and flowed westward through Sheffield, Clarendon, Stoneham and Glade, between which place and Warren it crossed the present channel of the Alleghany and flowed north into the St. Lawrence drainage system. On the northern bank of this stream and over 100 feet above its present level is a remnant of Mr. Leverett's "old drift." Between the time of its deposition and the excavation of the wide valley to present level he imagines that a long period has elapsed, and this excavation is his "great erosion." At Clarendon is more of his "old drift," also at Franklin; also at Parker. Bradford, being above Warren, is in the unglaciated area. The distances apart of these places are: Bradford to Warren (along the valley lines), 60 miles; Warren to Franklin, 60 miles; Franklin to Parker, 35 miles; Kittanning is about 25 miles below Parker. These distances enable us to employ the rule which obtains in geology as well as geometry, that when a number of points in a line or plane sufficiently distant from one another have been referred to a given datum plane, the portion of the line or plane included between those points has also been referred to the same plane. The datum plane in this case is the present drainage level of the Alleghany, and to it we will refer both the underlying rock bottom and the "old drift" of Mr. Leverett.

Our data for reference exist abundantly, as the region had been pierced from surface to great depths by tens of thousands of oil wells whose sections have been recorded, and many have been published. These wells are found in numbers on the "old drift," the "young drift," the mountain tops, the swamps and the river beds, and where rock was not near the surface a pipe was driven through the loose deposits till rock was struck. These "drive-pipe" records show the materials passed through, and form a valuable and conclusive array of facts beyond the possibility of cavil or argument.

The problem for discussion is the probable form and sequence of deposits over a region deeply flooded by an approaching but still distant glacier which forced the waters over a still more distant col which was gradually degraded. Every prospector and ore-dresser is well acquainted with the classifying and

sorting powers of streams of varying velocities, and nothing could more plainly show the distance of the glacier and the stagnation of the water than the varying thicknesses of clean sticky clay which universally lie against the rock floor of the region. Where bays to one side of the line of current offered especially still water its thickness runs up to 100 feet. Even on the hillside at Warren near the "old drift" and not far above present water level the writer has found it and taken fragments of wood therefrom. This presence of the broken pieces of the old forest in the clay is proof of a first invasion of the region, and at Bradford, Clarendon, Stoneham and elsewhere outside of the area of discussion the heaps of accumulated logs were so well preserved as to make the driving of the pipe to bed rock a most difficult operation. Even as far down the river as Kittanning this clay is so abundant as to furnish material for the manufacture of china. Above this the sequence of deposits is a fine quicksand resembling a friable clay; a coarser quicksand; sands, and, finally, gravels. Where there was continuous current action the lighter varieties are generally absent, and where it swept along one side of a valley with torrential force even the gravels are absent on that side, as at Warren, Franklin, Brandon, Kennerdell and numerous other places not noted in the many discussions of this region. At Bradford, Stoneham and Clarendon we have the whole series as it was laid down, as shown by the thousand wells of Bradford, the hundreds at Stoneham, and the 1,300 or more of the South Pennsylvania Company about Clarendon.

Regarding the alleged "old gravels" which are supposed to have been laid down in a river bed whose bottom was several hundred feet above present water-level, we find that they vary in level A.T. 100 feet or more within a few miles and around the shoulders of the same hill. Streams never run up hill and so there was no stream deposition at such places.

Coming from generalities to specific localities we find at Bradford, outside of the so-called Kansan area, that the valley for miles has a nearly flat surface, and the rock floor averages 200 feet below it. Taking the Clarendon-Stoneham-Glade-Warren rock floor of Carll's preglacial stream we find the drive pipes at the first place will run from 200 to 310 feet. The last was located on and ran through Mr. Leverett's "old drift." At Stoneham the average is 200 to 232 feet: at Glade, 100 feet: at Warren, and again on the "old drift" are several wells which place the rock floor on a slope running from present water level to fifty feet below it. The averages of the four localities above given show that the floor dips from Clarendon to Warren and will average 1,200 A.T., or below present water-level. This being the fact, the "old drift" patches are shown to be the youngest of a regular series, and as the rock floor level was determined before deposition began, there has been here no "great erosion." For 60 miles of the valley we can say "no erosion."

At Franklin we find rusty gravel on the hillside north of French Creek. The new water works enabled the writer to inspect a deep trench for the city mains which ran from just above water-level to several hundred feet up the mountain, where the reservoir was being built. As the trench went down to soil rotting in place there was a chance to see the soil line and to note that the sediments were washes parallel thereto, and carrying the same amount and kinds of foreign rocks throughout all elevations exposed. Here also the "old drift" lay on top of the wash, and there was no "erosion."

Parker was made much of, as here was an alleged "abandoned loop" of a mythical Alleghany of Kansan times. The writer showed, more than a dozen years ago in SCIENCE, that the wide difference in elevation, material and dip of the deposits precluded their being laid down by a stream, and this was proved by the usual oil well not very far from the Alleghany which went down through the "old drift" to below the present water level.

We have now performed our task, the reference of the "old drift" at Warren, Clarendon, Franklin and Parker to the present water level, and in all these places it lies over the old bottom as the uppermost of a regular

series laid thereon, showing conclusively that the bottom was leveled preglacially and that there has been no "erosion."

In view of these facts, which anybody can check, it is germane to the subject to ask Mr. Leverett to kindly be specific and state exactly where this "great erosion" occurred over the "upper Alleghany region."

Edward H. Williams, Jr.

ACADEMIC FREEDOM

To the Editor of Science: The dismissal of Professor Willard C. Fisher from the chair of political and social science at Wesleyan University, which has now been made formal and definitive by the acquiescence of the trustees in the action of the president, is an occurrence that shows the need of constant effort and discussion in order to maintain the right of freedom of speech and of teaching. The correspondence between President Shanklin and Professor Fisher, as published in a recent number of Science (February 14), is on its face sufficient evidence that a teacher who had served the institution for twenty years was summarily removed on grounds that are absolutely trivial and puerile. From various sources which seem reliable the report comes that Professor Fisher's address at Hartford was not the cause of his dismissal, but that the real ground is to be found in the objection felt by the president and some of the trustees of the college to his political and social views. If this is so, it only emphasizes the fact that there has been a serious infringement of the principle of academic freedom. The matter is too serious to be allowed to drop: it seems desirable that there should be protests from universities, learned societies and individuals so numerous as to arouse public opinion and render any similar occurrence impossible in the future. Physical science has fortunately no longer to fear any direct interference from outside authority. It is a long time since Galileo; and even the doctrine of evolution now calls out no protest from any quarter. But the representatives of these sciences will not fail to recognize that their own cause is bound up with that of the economists and social philosophers who now furnish the chief grounds of offence to the "interests." For freedom of speech and of research can not be limited to certain subjects: science can not exist half slave and half free. I conclude by quoting an extract from an address of President Schurman as reported in the *Cornell Sun* for September 24, 1897, which seems to me a fine statement of principles of which we should never lose sight.

> If it is asserted that the business of the college or university is to teach that which the average man may believe, or that which is acceptable to the university, or that which the board of trustees may assert as the truth, the answer must always be that such a course contravenes the very principle on which the university was founded, and however true it may be that the majority must rule in the body politic, the motto of the university must be, one man with God's truth is a majority. There is also a second principle involved in what has been said if all this be true. It is perfectly clear that every teacher must be free to carry out his inquiries and to announce and proclaim if he wishes what he has observed, or in dealing with the individual student the teacher must be free to present all phases of the question as they occur to him—otherwise he has missed his great vocation as a teacher.
>
> Money is needed by universities. I know it well. I know that our board of trustees is constantly wrestling with the problem of how to make both ends meet, how to meet the legitimate demands of the heads of departments and colleges, yet if money is to be got for the institution by the suppression of the truth, by setting any limitation whatever upon the freedom of the teachers to inquire or to announce the results of their inquiries, better a thousand times that the institution should go out of existence. The end of a university is truth and the promotion of truth. Money may be a means to that end, and as a means it may kindle a great light; as an end it can only produce total darkness. Hence any attempt to set limitations upon the independence of the teaching staff must be resisted, must be unwarranted. We need for the advance of civilization the striking out of new ideas or the application of old ideas to new fields. Where are such ideas to be urged, if the business of the university is to teach what is acceptable to the community? All science would be impossible on this theory.

It was perhaps more than a coincidence that this address was delivered soon after the resignation from Brown University of President E. Benjamin Andrews.

J. E. CREIGHTON

CORNELL UNIVERSITY.

SCIENTIFIC BOOKS

The British Tunicata. An Unfinished Monograph by the late JOSHUA ALDER and the late ALBANY HANCOCK, F.L.S. Edited by JOHN HOPKINSON, F.L.S., F.G.S., etc., Secretary of the Ray Society, with a history of the work by the Reverend A. M. NORMAN, M.A., D.C.L., F.R.S., etc. Volume I., 146 pp., 20 pls., 1905; Volume II., 162 pp., 50 pls., 1907; Volume III., 90 pp., 66 pls., 1912. The Ray Society.

With the appearance during the last year of a third volume of Alder and Hancock's researches on British ascidians all that is to be printed of this magnificent work is now available to students. The earlier volumes have been duly noticed by reviewers as they were distributed; but for the sake of completeness it will not be amiss to speak of all three volumes together.

The task of selecting and preparing the manuscript and illustrations must have been both perplexing and laborious, for we are told by Canon Norman in his history of the work which introduces the first volume, that the drawings, particularly those by Hancock, are very numerous and in many stages of completion. The bracketed words, sentences and paragraphs scattered all through the text testify to the extensive and painstaking work performed by Mr. Hopkinson.

Very wisely not much has been added to or subtracted from the work as it left the hands of the authors. The diagnoses of species of the compound ascidians have received more editorial modifications than have those of the simple ones. In a few instances species and genera have been included which did not appear as such in the manuscript, but only where the notes and sketches warranted.

The part played by Canon Norman in bringing the work to the light of day was undoubtedly done under the stimulus of personal devotion and direct scientific interest, his friendship for and association with the authors having been intimate and of long standing, and he contributed much, particularly in the way of specimens, to the substance of the monograph. Mr. Hopkinson's rôle seems to have been solely that of an official and a man of science, and what he has done is a fine testimonial to his ability in this way.

Volume I. contains, as mentioned above, a review of the origin and vicissitudes of the work, by Canon Norman; an introduction by the authors; a reprint of Hancock's "On the Anatomy and Physiology of the Tunicata" originally published in the *Journal of the Linnean Society of London* in 1867; and the systematic treatment of all the species of the genus *Ascidia.* Volume II. opens with a life of Alder by Norman, and of Hancock by Embleton, and deals with the remaining genera, *Ciona* and *Corella,* of the family Ascidiadæ, and the families Molgulidæ, Cynthiadæ, and Clavelinidæ. Volume III. treats of the "Aggregatæ," of which three families, Polyclinidæ, Didemnidæ and Botryllidæ, are recognized, and ends with a supplement by Mr. Hopkinson containing "Additional References and Localities"; a "List of the Species described in the Monograph, with the Genera under which they would probably now be placed," and a "General Index."

There can be no question about the value of this monograph, even though it represents the state of knowledge of ascidians as it was forty years ago, and makes no pretense of concerning itself with other than British species. Its chief utility will naturally be as a handbook for British students and other persons who frequent the shores of the British islands. The great number and excellence of the illustrations, particularly those of habitus of the kinds, "forms," varieties and species, mostly by Alder, will make it specially useful in this way. Nearly all the figures, even the anatomical ones from Hancock's faithful brush, are in color. The authors evidently devoted much less time to the compound than to the simple species; and for illustrating

these the editor has largely supplemented the original drawings from figures by Savigny and Milne Edwards. But the usefulness of the book will be by no means restricted to students who are countrymen of the authors. It will undoubtedly take a conspicuous place in the working library of specialists in the group wherever located, as it already has in that of the reviewer.

Divers reflections are induced by reading the divers things said in these volumes by divers persons. The brief, straightforward account by Canon Norman in Volume I. of how the monograph came to be undertaken relates that Alder was requested by the keeper of the zoological department of the British Museum to prepare a "Catalogue of British Tunicata" as one of the series of catalogues then being issued by the Museum; that Alder at once took up the task and pushed it to the exclusion of everything else; and that after several years' work when he reported the manuscript ready to be turned in he was informed by the keeper (with the deepest regret) that somebody had withdrawn the grant for publishing the catalogues, and that consequently his work could not be published. In the absence of information to the contrary this looks like a flagrant breach of contract on the part of the Museum, and reminds one of the frequent charge that institutions and governments hold themselves less bound by contracts than individuals are supposed to be held. If this be so the fact can only mean that communities in which it is true are still in an immature stage of advancement in civilization, so that as time goes on and with it progress it will be impossible for such cases of broken faith to occur.

The extent to which embryological knowledge may modify interpretations based solely on anatomical knowledge could hardly be more strikingly illustrated than by Hancock's ideas about the homologies of tunicate organs. He knew almost as much as we of to-day know about the gross structure of full-grown ascidians, yet he considered the close kindred of the group with the polyzoa to be fully established! The proposal made by several zoologists to separate the ascidians from the molluscs he looked upon with great disfavor, and his efforts to prove the resemblance between the respiratory apparatus of an ascidian and that of a bivalve mollusc seem curious enough to us now. Of course he was familiar with the tadpole stage of the individual ascidian, though he thought it a secondary acquirement. But it is not alone with reference to these broad generalizations as to group affinities and classification that discoveries in development have changed morphological ideas. There is hardly a page of Hancock's essay that does not contain some interpretation, expressed or implied, which does not accord with present views. Kowalevsky's epochal "Entwickelungsgeschichte der einfachen Ascidien" was published in 1866, and although Hancock's "On the Anatomy and Physiology of the Tunicata" did not appear until the next year, there is no indication that the English comparative anatomists had read the memoir of the Russian embryologist.

In an addendum to the biographies of the authors which introduce the second volume, Canon Norman remarks that Alder and Hancock were "naturalists of a by-gone time." "With only very moderate advantages," he says, "as regards early education, they progressed greatly in knowledge by private study as years went by. An intense love of nature absorbed them, and they realized that everything else must be sacrificed to allow them to find out nature's secrets." When one recalls that these were only two among a considerable number of Britishers of that period who, largely self-trained, passed all or a great part of their lives in unremitting toil as investigators of nature, and did this without compensation or institutional aid, he can but be mindful how unqualifiedly true is Norman's remark about a by-gone age. Undoubtedly the refinements of method in nearly all departments of research, necessitated by the advancements that have been made, account in large measure for the almost entire disappearance of this type of scientific men. The professionalizing and institutionalizing of science in our day as compared with former days have

been, inevitably, both result and cause of the wonderful progress that has gone on. Surely there is neither possibility nor desire to return to the conditions of a half-century ago. But a certain quality or attitude of mind essential, according to the reviewer's notion, to the best achievements has been lost since the former days. Reference may be made to what some astronomer, Professor Hale I believe, has extolled as the amateur spirit in science: a spontaneous, perennial curiosity; a wide-awakeness of perception; an openness of mind; and a nimbleness of imagination, as touching all sorts of objects and processes and incidents in one's surroundings. The belief prevails widely among biologists of the present day that this sort of thing necessarily begets superficiality—that it is inimical to that profundity demanded by the deep, ultimate problems which constitute the soul of science. The belief is, however, not justified by either the history of scientific discovery, or our modern knowledge of the constitution and workings of the human mind. The "complex" of recent psychology is a "system of connected ideas with a strong emotional tone"; and specialization may go so far in both differentiation and intensification as to tend to reduce the system of ideas to one idea, and to destroy the "emotional tone."

Such works as the one now before us, taken in their entirety, ought to serve the two-fold end of helping on knowledge in a restricted field of zoology, and of restoring to biological research something of the amateur spirit.

WM. E. RITTER

List of North American Land Mammals in the United States National Museum, 1911. By GERRIT S. MILLER, JR., Curator, Division of Mammals, United States National Museum. Bulletin 79, United States National Museum. Washington, Government Printing Office. 1912. 8vo. Pp. xiv + 455.

This volume is a most welcome contribution to mammalogical literature, giving, as it does, in systematic sequence, the names of the species and subspecies of all North American land mammals currently recognized down to the end of the year 1911, and a large part of those described during 1912. "North America," for the purpose of the list, comprises "the entire continent from Panama northward, together with Greenland and the Greater and Lesser Antilles." It consequently includes the Island of Trinidad, which is, faunally and geographically, really South American. According to the author's tabular summary, the number of "forms" included in the list is 2,138, of which 1,955 are represented in the United States National Museum, leaving only 183 as unrepresented. The types of about one half of the total number of forms are in the National Museum.

The plan of the list is about as follows: The classification, or "sequence of groups is, in its main features, that adopted by Osborn in his 'Age of Mammals,' 1910, though the arrangement of the families and genera has been revised to make it as consistently as possible in harmony with that of the higher groups." References are given to the place of first publication of all generic, specific and subspecific names, and types are designated for the genera. In the case of species and subspecies, reference is usually made to the first use of the binomial or trinomial here adopted, and to True's list of 1885. "The type locality of each form is stated with all possible exactitude; and in revised genera the ranges are given as printed by the author," references to such revisions being given in footnotes.

The list includes: (1) species and subspecies that "had not been questioned in some recent work of definite monographic character" prior to the end of the year 1911; (2) forms belonging to groups which have not been treated in a monographic paper; and in cases where differences of opinion regarding their status have developed, "references are given to the conflicting views," at least in most cases. The utility of this work to investigators is further enhanced by an asterisk prefixed to the names of forms contained in the National Museum, and also a dagger in case the museum also has the type. The author has of

course expressed his preferences in deciding disputed questions of nomenclature, of which a few might well be referred to the International Zoological Congress for arbitration.

As already stated, the number of species and subspecies of North American land mammals is in round numbers about 2,150, without including a considerable number described late in the year 1912. The first enumeration comparable in geographic area with Mr. Miller's was published by True[1] in 1885, numbering 365 species and subspecies. This number, according to Miller and Rehn,[2] had increased by the end of the year 1904 to 1,450. Elliot, in 1905, in his "Check List of the Mammals of the Continent of North America, the West Indies and the Neighboring Seas,"[3] included 1,940 forms of land mammals, he listing a considerable number that have since, through the work of monographers, passed into synonymy. Doubtless when other groups are subjected to this ordeal many listed in the present check list will also lapse, so that the number now fairly entitled to recognition may be estimated at about 2,000. Probably many valid additions are yet to be made from parts of Central America now very imperfectly known.

The task of preparing the present list could hardly have fallen to more competent hands, and mammalogists owe a debt of gratitude to its author for the great aid it will be to them in their work. It is to be regretted, however, that so unusual and confusing a system of classification has been adopted, the scheme being based on specialization, the sequence of the higher groups being determined by the amount of their departure in structure from the most "primitive" or "generalized" mammalian type, and not on affinity or genetic relationship. The arrangement therefore will be very confusing and unprofitable to nine tenths of the users of Mr. Miller's book, who have been led to suppose that the purpose of a system of classification designed for general use was to indicate, so far as possible in a linear sequence, the affinities of the animals classified. The classification here adopted may serve the purpose for which it was intended—an expression of the relative degree of specialization among the ordinal groups of mammals; but it is rather startling to the uninitiated to find the two ends of the series represented, respectively, by the Monotremes and the Cetacea, and the Primates flanked on one side by the Edentates and on the other by the Artiodactyls: In other words, to find an otherwise admirable check list of the mammals of a continent arranged in conformity to a scheme of classification which ignores genetic relationships and therefore is out of touch with current faunistic and systematic work on recent mammals.

J. A. A.

[1] True, F. W., "A Provisional List of the Mammals of North and Central America and the West Indian Islands," *Proc. U. S. Nat. Mus.*, Vol. 7, 1884, pp. 587–611 (appendix, 1885).

[2] "Systematic Results of the Study of North American Land Mammals to the Close of the Year 1900," *Proc. Boston Soc. Nat. Hist.*, Vol. 30, pp. 1–352, December, 1901.

[3] Field Columbian Museum, Zool. Ser., VI., 1905.

General Chemistry of the Enzymes. By Hans Euler, Professor of Chemistry in the University of Stockholm. Translated from the German by Thomas H. Pope. New York, John Wiley and Sons. Pp. 323.

The chemical changes which are taking place continually in plants and animals fall, for the most part, under that branch of science which is called organic chemistry. It is characteristic of organic reactions that they proceed slowly, though their progress can often be hastened by the addition of small amounts of particular substances, the so-called catalysts. This property of hastening the speed of organic reactions by supplying an appropriate catalyst is wonderfully developed in living organisms, because the element of time is all-important to them. The catalysts which occur in organisms are given the general name of enzymes. In many cases they can be readily separated from the cells of the organism and they are accordingly considered to be organic chemicals, probably of complex composition, but without organized or cell structure. Up to the present time no one has succeeded in crystallizing or vaporiz-

ing an enzyme and therefore such a thing as a pure enzyme is now unknown. For this reason the chemical analyses of dried "enzyme preparations" signify little, because it is impossible to know what portion of the preparation is enzyme and what is impurity. Pending the discovery of some method for crystallizing enzymes this branch of their study is practically at a standstill. On the other hand, the study of the mode of action of enzymes and the influence of temperature, acids, etc., upon their catalyzing power is advancing rapidly and it is with this subject that Professor Euler's treatise deals. To quote from the preface, he "has attempted to review the more important facts of enzymology from a general standpoint and to fit them, as far as is possible, into their proper places in the fabric of general and physical chemistry." This book is the first in which an attempt has been made to describe this branch of science from the standpoint of theoretical chemistry and special credit is due Professor Euler for his excellent treatment of the subject. The following chapter titles may serve to give an idea of the contents of the book: Special chemistry of the enzymes, their physical properties, their activators and poisons, the chemical dynamics of enzyme reactions, the influence of temperature and radiation on enzymic reactions, the chemical statics of enzyme reactions, enzymic syntheses and the specificity of enzyme action. The work of translation by Mr. Pope has been very carefully done. The publishers are also to be commended for the quality of the printing and binding.

C. S. HUDSON

SPECIAL ARTICLES

MITOCHONDRIA IN ASCARIS SEX-CELLS

DURING the course of preparation of a thesis for the Doctor's degree at the University of Pennsylvania, entitled "The Spermatogenesis of *Ascaris megalocephala* with special reference to the two Cytoplasmic Inclusions, the *Refractive Body* and the *'Mitochondria'*; their *Origin, Nature* and *Rôle* in Fertilization," the following observations were made:

The refractive body arises, as Marcus (1906), Mayer (1908) and Romieu (1911) point out, by the fusion of the refringent vesicles while still in the vas—probably just before copulation occurs. The refringent vesicles arise from minute granules scattered here and there throughout the cytoplasm in the early growth period of the spermatocyte. These granules stain blue after the material is fixed in Benda's modification of Flemming's strong solution and stained in Benda's "Krystal Violet." This reaction is characteristic of true mitochondria. Granules staining exactly like these are found constantly in the nucleus of the spermatogonium, *and these actually pass through the nuclear membrane* into the cytoplasm of the spermatocyte. This blue staining material, or true mitochondria, is apparently derived directly from the chromatin because in several cases chromosomes in the spermatogonial nuclei were cut, showing the red-brown interior (the typical reaction to Benda's stain for chromatin) covered by a blue layer. Thus the refractive body is ultimately derived from the chromatin of the spermatogonium, and it is formed by true mitochondria; these are not only nuclear in origin, they are derivatives of the karyosome. They should, therefore, be called *karyochondria* to distinguish them clearly from the *plastochondria* (Meves) which are derived from the plasmosome of the spermatogonial nucleus.

The refractive body has but one function—namely, to feed the spermatozoon on its long and exhausting journey (by pseudopodial creeping) to the "entrance region" at the proximal end of the uterus. This is proven by the fact that many eggs are entered there by spermatozoa which have lost every trace of the refractive body; and further, by the fact that the decrease in size of this body takes place equally from all sides, showing that it is the surrounding layer of cytoplasm, and not the uterine epithelial cells, as all other authors maintain, which is the agent of its absorption. Not only is its axial symmetry maintained during the stages of degeneration while crowded between the epithelial cells, but also when lying amongst eggs far out in the

lumen of the uterus. So it is fed upon only by the sperm itself.

The nematodes should, therefore, be placed in Faure-Fremiet's (1910) fourth class of mitochondria-bearing sex-cells, in which these granules produce yolk.

Marcus, Mayer, Romien and Faure-Fremiet use the term mitochondria to describe minute plastin granules found in the nucleus of the spermatogonium and in both nucleus and cytoplasm of the spermatocyte. They are easily seen in the "perinuclear zone" of the spermatid and in the "crown" of the spermatozoon. But nowhere do these granules take Benda's Krystal violet stain or transform into any cell structure. Hence they have no relationship with true mitochondria. Meves recognizes their nature and origin and calls them plastochondria. Van Beneden called them "protoplasmic corpuscles"; Altmann, "microsomes"; Boveri, "archoplasm." But none of these observers attributed any importance to them as bearers of hereditary characters. Meves (1910), however, finds (like the brothers Roja, 1891) that these granules fuse with similar ones in the egg after fertilization occurs, and he believes, with only this observation as a basis for it, that these plastochondria are the bearers of paternal structural characteristics. I have carefully studied the origin and behavior of these granules throughout the spermatogenesis and find that they everywhere behave, like the plasmosome itself, as if they were waste products of the metabolic processes of the chromatin. Many of them are actually thrown off by the spermatid with the cytoplasmic lobe, not only in *Ascaris*, but in many other forms. They always take plasma stains, yellow after Benda, and red after Ehrlich-Biondé, both reactions characteristic of secretions; they are pulled about in the cell by the force of the centrosomes to form aster rays and spindle fibers of the cleavage figure; they never divide, nor grow except by fusion on actual contact; in short, they behave everywhere as inert formed products only.

I believe that the observed facts of artificial parthenogenesis, hybridization and fertilization of enucleated eggs, all argue against Meves' interpretation of the rôle of the plastochondria; while these facts and the observations of Baltzer, Tennant and others show clearly that it is the retention or elimination of chromatin (or the karyochondria) that determines the inheritance of paternal characters, segregation and dominance.

Edward E. Wildman

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION E—GEOLOGY AND GEOGRAPHY

The sixty-fourth meeting of Section E, Geology and Geography, of the American Association for the Advancement of Science, was held in the geological lecture room, main building, Case School of Applied Science, December 30, 1912, to January 2, 1913. Vice-president James E. Todd presided. The address of the retiring Vice-president, Professor B. Shimek was given on the subject, "The Significance of the Pleistocene Mollusks." Much interest was taken in the papers, which are here given with abstracts:

Esker Terraces in Ohio: G. Frederick Wright.

The Wisconsin Drift-plain in the Region about Sioux Falls, S. D. (illustrated): J. Ernest Carman.

The region considered lies to the south of Sioux Falls along the line between Lincoln and Minnehaha counties, South Dakota. Professor Todd and others have interpreted it as belonging to the Wisconsin drift-plain, being an eastward projection of the James River lobe to the Big Sioux Valley. Professor Shimek has recently decided that the region is a Kansan drift-plain and not Wisconsin. The present paper describes the characteristics of this plain north and west of Shindlar and compares it with the typical Kansan region to the north and east. The evidence, chiefly physiographic, indicates that the region is a Wisconsin drift-plain. The conclusions of the paper support, in the main, the earlier interpretation of Professor Todd.

The Pleistocene Succession in Wisconsin: Samuel Weidman.

A brief statement is given concerning present knowledge of the drift and associated surface deposits in Wisconsin, with a map showing distribution of the formations. There appear to be

five drift sheets exhibited in Wisconsin, as follows: First drift, a very old, thin drift; second drift, a very old, thick drift correlated with the Kansan of northeastern Iowa; third drift, a relatively old, thin drift, correlated with the Iowan of northeastern Iowa; fourth drift, a relatively thin, fresh drift, correlated with the early Wisconsin of northeastern Illinois; fifth drift, the Wisconsin drift. Extensive alluvial and lacustrine deposits in old valleys and lowlands, of interglacial origin between the second and third drifts. The loess deposits are of later origin than the third drift and older than the fourth.

The "Moraines" of Kansas: J. E. TODD.

Certain bouldery hills have been designated as glacial moraines by several writers on Kansas geology. This paper discusses their locations and relations to the former Kansan Ice sheet and present lines and levels of drainage and shows that they are not true moraines but river-laid deposits.

Traces of an Early Wisconsin Flood: J. E. TODD.

Attention is called to a deep silt which fills portions of the valleys of the Missouri and Kansas rivers in eastern Kansas, and which can not be correlated with the loess, because of its lower level. Because of evidences of the excavation of the valley so filled during and after the Kansas stage of the ice, it is argued that the date of the deposition of the silt was coincident with the recession of the Early Wisconsin Ice, or more definitely after the formation of the Altamont, or first marginal moraine. This lower loess or terrace silt is further provisionally correlated with terraces along the Missouri further north and its tributaries in western Iowa.

The Sangamon Interglacial Stage in Minnesota: WARREN UPHAM.

Three chains of lakes on the till area of Martin County, one of the central counties of the southern tier in Minnesota, adjoining Iowa, are ascribed to interglacial erosion of rivers flowing south, where now the courses of drainage pass eastward. The duration of this interglacial stage is estimated by Winchell, from changes of the course of the Mississippi River in and near the Twin Cities of Minneapolis and St. Paul, to have been about 15,000 years. It seems to be represented in the history of the Quaternary lakes Bonneville and Lahontan by the stage of their desiccation between their previous prolonged stage of high water and their ensuing higher but more brief rise of water; and it is correlated with the Sangamon interglacial stage between the Illinoian and Iowan stages of glaciation. Its time is estimated to have been approximately from 40,000 to 25,000 years ago.

The Relation of the Keewatin and Labrador Areas of Glaciation: WARREN UPHAM.

The Kansan and Illinoian drift sheets are regarded as mainly of contemporaneous age. They were deposited respectively by the farthest southward extensions of the Keewatin and Labrador icefields. The belt of confluence of these icefields extended from the borders of the drift northward along or near the course of the Mississippi River up to the Wisconsin driftless area, which also reaches short distances into Illinois, Iowa and Minnesota. Beyond the driftless area, these Keewatin and Labrador currents of the continental ice-sheet were confluent along a belt or line passing north-northwesterly through Minnesota to the vicinity of Winnipeg, Manitoba and onward along the axis of Lake Winnipeg. At St. Paul and Minneapolis and northward, fluctuations of the line of confluence during the Wisconsin stages of glaciation produced extensive interbedding and sometimes a confused mingling of the Keewatin and Labrador drift formations.

Types of Iron Ore in Tennessee: C. H. GORDON.

Read by title.

Criteria for Distinguishing Various Sorts of Common Deposits (illustrated): A. C. TROWBRIDGE.

The Age of the Mesabi Iron-bearing Rocks of Minnesota: N. H. WINCHELL.

This paper gives a very brief summary of former opinion, and presents new evidence which goes to show that the Mesabi rocks are a part of the great Keweenawan formation.

Angular Amphitheaters of the Grand Canyon: CHARLES R. KEYES.

One of the most perfectly enigmatical features concerning the physiognomy of the Grand Canyon, in Arizona, and one to which little especial attention has been directed, is a certain regularity in the notably serrated character of the walls. Buttresses, reentrants and pyramids have a conspicuously rectangular ground-plan. So pronounced is this characteristic and so large is the scale that it is even emphasized in the latest contour-maps of the district. The angularities of the buttresses and pyramids are readily explained by the double system of master-joint structure. The deep reentrants or amphitheaters are not so easily disposed of, especially since all of the surface drainage, which is very deficient, of the general plateau

on either side of the canyon is directed away from the margin of the walls and not into the great trough. In some cases these reentrants are partially accounted for by the presence of faults trending transversely to the course of the river. In the majority of other cases the amphitheaters, great and small, appear to have originated through undercutting by differential wind action, the deflative effects being much more vigorous on the soft shales lying between the hard Carbonic limestones forming the upper wall and the hard granite floor of the inner canyon.

Geologic Significance of Enisled Relief: Charles R. Keyes.

Sharp meeting of lofty mountain and even plain, seemingly as level as the ocean strand-line, is one of the most characteristic features of desert landscapes. Foothills are also conspicuous by their absence. The very deficient rainfall of such regions can not possibly produce such topographic peculiarities. On the Mexican tableland, for instance, where the geologic structure presents a great thickness of soft later deposits, and the whole selberglandschaft of the Germans is probably more ideally perfect than anywhere else on the globe. A number of typical illustrations are described. The phenomena are best explained by the action of regional eolation, or general leveling and lowering of the country through deflation.

Some Upland Flats in Jo Davies County, Illinois: A. C. Trowbridge.

An attempt to distinguish between raised peneplains, structural plains, plains of marine deposition and plains of marine erosion, in regions of nearly horizontal strata.

The Value of Geochemistry to Geology and Geography: J. Culver Hartzell.

The author stated that geology is the history of the earth, including organisms; geography is that part of geology which deals with the surface of the earth, and man in particular, and his relations to topographical, cultural, political and climatic environments. We are apt to forget the relations which the atmosphere, the hydrosphere and lithosphere bear to each other. Diastrophism, vulcanism and gradation are important; but the geochemistry is as important as the mechanics when changes in the equilibrium of chemical systems and their relation to man are considered. Atoms are different manifestations of one primal force. The farther we get away from *primal* the more distinct *chemical* and *physical* seem. There are pure and applied methods of procedure; but the pure and applied principles are interdependent in the proper and accurate interpretation of facts. The value of geochemistry lies in the fact that it touches every division of geology in both its philosophy and its applicability. We need to get away from a sole contemplation of finished products. All forces are so balanced as to produce systems which are more or less stable; but which may be disturbed in such a way as to produce new systems which may in turn become more or less stable. These disturbances in equilibrium are as vital to the geologist as the system *per se*. We know a little about the balancing of forces; but the balancings are so multifarious as to be almost overwhelming, and it is only by careful, persistent investigation, interpretation and application of forces and the formulation of laws (perhaps tentative) that we can hope to know the genesis of any one system and its possible disturbance, thus accumulating a mass of data relative to many systems the final interpretation of which will make clear many of the heretofore apparently unsolvable problems. Stability, unstability and disturbance cross our path and we must determine their relations. The atmosphere, hydrosphere and lithosphere were discussed. The reactions which take place, the manner and time of occurrence, the phenomena and the final results are the problems of the geochemist. The solution of these problems has a direct bearing on topographical, cultural, political and climatic effects as well as on diastrophic, volcanic and gradational effects. They also have a direct bearing on the igneous, metamorphic and unconsolidated portions of the lithosphere as well as on the morphological and mathematical relations of minerals and their chemical molecular arrangement, and the conditions of fossilization with reference to the changes in the solid parts of organisms.

The author is greatly indebted to Dr. Frank Wigglesworth Clarke's "Data of Geochemistry," and to Alfred H. Brooks's presidential address before the Geological Society of Washington, December 13, 1911, for the thoughts here presented.

Gas and Oil Wells near Oberlin, Ohio: George D. Hubbard.

Exploitation of the Clinton sands of the Clinton formation northward from the Bremen field to Lorain County has gone far enough to find several good wells in the vicinity of Oberlin. Mostly gas of good quality; some yield oil too. Gas is found at a depth of about 2,170 feet below

surface which is at about 750 feet. Section contains much water in the limestones, also several feet of salt. Anticlinal theory does not seem to apply; gas is apparently in pockets or lenses of the sand in the calcareous shales. These sand beds are not continuous. Rock pressure varies in different wells from 600 to 950 pounds, and flow from 1,000,000 to 5,000,000 cubic feet per day.

The History of the Bajadas of the Tucson Bolson of Arizona: S. S. VISHER.

The bajada is the long, gentle slope of detrital material at the foot of the mountains in bolsons or areas of centripetal drainage. The bajadas near Tucson have a length of about 10 miles and an average slope of 2° or 100 feet per mile. In spite of a difference of 8° or more in slope between the lower four miles of the canyons and the upper four miles of the bajada, erosion is now taking place on all portions of these thick terrestrial deposits. The explanation for this widespread erosion has been sought by many. The higher portions would, as shown by Salisbury, be eroded as the highlands were lowered, but not the lower portions, nor are certain other features to be thus explained. Over-grazing does not appear to be a sufficient cause. Davis concludes that in maturity the adjustment between one bolson and an adjacent lower one may result in the terracing in the higher. Changes of climate have been advocated: Barrell considers that bajadas were formed during the various glacial epochs and have since been destroyed; Huntington believes bajadas were formed in the interglacial epochs, of material which accumulated in the mountains during the glacial epochs. The present terracing he correlates with a recent increase of precipitation. The latter apparently opposing theories for bajada formation are in this region seemingly both essentially correct—Barrell's of the bajadas surrounding the lower, barren, warmer ranges, and Huntington's those of the higher, forested, cooler mountains upon which glacial conditions were approached since the bajadas of the former are more gentle, have a smaller percentage of clay and are more extensively eroded than those of the larger ranges. The frequency of freezing temperatures are believed to be important. At Tucson a decrease of 10° F. would increase the frequency about 200 per cent. and a 20° decrease would result directly in frost about 250 nights in the year. A different distribution of the precipitation would greatly effect the vegetal covering. The percentages of clay and boulder formation would fluctuate accordingly as would also accumulation and transportation. The Tucson bajadas appear to have been mainly formed at a time when the average temperatures were 10° or more lower; when the precipitation was greater and more uniform—either chiefly late in the glacial epochs (smaller ranges) or at their close (larger ranges). The present terracing is perhaps due to an increase in temperature and a different distribution and amount of rainfall abetted by the advancement of the area in the geographic cycle.

The Relation of the Lime Creek Shales to the Cedar Valley Limestones of Floyd County, Iowa: A. O. THOMAS.

The Devonian system of Iowa is represented by sediments belonging to two series, the Middle and the Upper Devonian. The stages of the Upper Devonian do not overlie each other, but each is locally developed and geographically separate. Moreover, each lies unconformably on the Cedar Valley stage of the Middle Devonian. Field study in Floyd County on the areal distribution and geological relations of the Lime Creek stage of the Upper Devonian has demonstrated a widespread unconformity at its base. A new substage, for which the name Nora limestone is proposed, is added as the lowest member of the Lime Creek stage.

A Four Mile Section along the Missouri River South of Columbia, Missouri: E. B. BRANSON.

Strata are well exposed along the bluff of the Missouri River and are, in general, nearly horizontal. Eight distinct and well-exposed unconformities occur within four miles.

The Relation of Geological Activity to Conservation of Soil and the Waters of Flowing Streams: LUELLA AGNES OWEN.

A view of the advance of geology as a science, and of early geological research, shows the growing appreciation of the all-important power of water in the development and progress of continents as well as their destruction or partial denudation for continual rebuilding. All atmospheric forces unite their energy with that of the flowing streams in every land to work without rest in tearing down the high places of the earth and transporting the waste for renewal of valleys and building new coast lines. So, the present geological epoch is preeminently the Age of Rivers, and in necessary works of conservation man may change the application of natural law to meet his needs and pleasure, but the law itself is unchangeable.

Rock Classifications in Three Dimensions: Alexander N. Winchell.

Believing that tabular classifications are desirable because of their simplicity, but that, as previously devised, they are unnecessarily limited in their presentation of mutual relationships, a new classification of igneous rocks is presented which is in tabular form in three dimensions. It is based largely upon the principles and work of Rosenbusch, but it differs from his usage in various important respects, so that responsibility for it must lie with the author.

Geo. F. Kay,
Secretary Section E

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and sixty-second regular meeting of the society was held at Columbia University on Saturday, February 22, extending through the usual morning and afternoon sessions. The attendance included thirty-eight members. Ex-president H. S. White occupied the chair, being relieved by Professors E. W. Brown and Frank Morley. Sixteen new members were admitted: Professor E. P. Adams, Princeton University; Dr. H. L. Agard, Williams College; Professor Fiske Allen, Kansas State Normal School; M. Farid Boulad, Egyptian State Railways; Professor J. A. Caparo, Notre Dame University; Mr. C. H. Clevenger, Kansas State Agricultural College; Dr. A. L. Daniels, Jr., Yale University; Mr. W. Van N. Garretson, University of Michigan; Mr. G. M. Green, Columbia University; Mr. C. E. Love, University of Michigan; Dr. Thomas Muir, Education Office, Capetown, S. A.; Mr. J. A. Nyberg, University of Wisconsin; Dean Marion Reilly, Bryn Mawr College; Professor B. L. Remick, Kansas State Agricultural College; Professor W. V. Skiles, Georgia School of Technology; Mr. J. N. Vedder, University of Illinois. Five applications for membership were received.

The society is about to publish the lectures delivered at the Princeton colloquium in 1909 by Professors G. A. Bliss and Edward Kasner.

The following papers were read at this meeting:

Harris Hancock: "A theorem in the analytic geometry of numbers."

B. H. Camp: "The expression of a multiple integral as a simple integral."

G. M. Green: "Projective differential geometry of triple systems of surfaces."

C. A. Fischer: "A generalization of Volterra's derivative of a function of a curve."

L. B. Robinson: "Notes on the theory of systems of partial differential equations."

Oswald Veblen and J. W. Alexander, II.: "Manifolds of n dimensions."

R. G. D. Richardson: "Oscillation theorems for linear homogeneous self-adjoint partial differential equations with one parameter."

L. P. Copeland: "Concerning the theory of invariants of plane n-lines."

T. H. Gronwall: "On the summability of Fourier's series."

T. H. Gronwall: "On Lebesgue's constants in the theory of Fourier's series."

T. H. Gronwall: "On the degree of convergence of Laplace's series."

N. J. Lennes: "Note on Lebesgue and Pierpont integrals."

N. J. Lennes: "Finite sets and the foundations of arithmetic."

H. Bateman: "The expression of the equation of the general quartic curve in the form $A/xx' + B/yy' + C/zz' = 0$."

H. Bateman: "Sonin's polynomials and their relation to other functions."

Dunham Jackson: "On the accuracy of trigonometric interpolation."

C. E. Wilder: "On the degree of approximation to discontinuous functions by trigonometric sums."

Edward Kasner: "Systems of curves connected with equilong transformations."

The next regular meeting of the society will be held at Columbia University on Saturday, April 26. The Chicago Section will meet at the University of Chicago on Friday and Saturday, March 21–22. The San Francisco Section meets at Stanford University on Saturday, April 12.

F. N. Cole,
Secretary

THE ACADEMY OF SCIENCE OF ST. LOUIS

At a recent meeting of the academy held on February 17, 1913, Professor Nipher presented an abstract of a paper soon to be published by the academy, entitled "A Local Magnetic Storm."

The phenomena were produced by means of two steel magnets, placed on opposite sides of a magnetic needle, as in the Gaussian method of deflection. The needle was completely enclosed in a copper cylinder. Its motion was observed through a small glass window, covered with wire gauze, by

means of a telescope and scale. The needle was in the magnetic meridian, the two deflecting magnets being balanced against each other. The needle was also loaded with a few copper wires, and the earth's field was partially compensated, so that the period of oscillation of the needle was about twenty seconds. When one of the deflecting magnets is then connected with either terminal of an influence machine, the other terminal being grounded, its deflecting effect on the needle was increased. This effect was found to be varied by disturbances of the air in the room due to the movement of an assistant. The observed effect was not appreciably modified by wrapping the magnet in tinfoil. A puff of tobacco smoke over the deflecting magnet also changed the apparent deflecting effect. It gradually became apparent that a change in the permeability of the air was produced, when the magnet was put into contact with the influence machine in an adjoining room. Apparently, the electrified molecules of air arranged themselves along the lines of the magnetic field, with the planes of rotation of the electrical whirls within the molecules set at right angles to the magnetic lines. The permeability of the air was thus increased, in somewhat the same way that iron filings in the field of the magnet would increase it.

When the electrified air around the magnet is disturbed by a palm-leaf fan, the permeability of the air is decreased. By proper timing of these disturbing effects of the fan, the amplitude of swing of the needle may be gradually increased to four degrees of arc. By operating the fan during the other semi-vibration of the needle it may be brought quickly to rest.

Professor Nipher is now seeking to obtain photographs of auroral displays around the poles of a steel magnet.

GEORGE O. JAMES,
Corresponding Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

THE eighty-sixth regular meeting of the Botanical Society was held at the Cosmos Club, Tuesday evening, February 4, 1913.

The following persons were elected to membership: Professor R. Kent Beattie, Dr. Charles Brooks, Mr. J. G. Grossenbacher, Dr. Neil E. Stevens.

The following program was presented:

MR. T. H. KEARNEY: *Indicator Value of Natural Vegetation in the Tooele Valley, Utah.*

This paper outlined the results of an investigation conducted last summer by the Offices of Alkali and Drought Resistant Plant Investigations and of Biophysical Investigations of the Bureau of Plant Industry. The Tooele Valley lies between the Oquirrh and Stansbury ranges and extends to the south shore of Great Salt Lake.

It was found that the valley is occupied by some half dozen principal plant associations, each of which is characterized by the presence of one, or, at most, two dominant species of shrubs or perennial herbs. The presence of one or another association was found to be closely indicative of the moisture relations and salt content of the substratum. The areas occupied by the different associations are often so sharply defined as to be recognizable at a distance of several miles.

The presence of a good stand and growth of sage brush (*Artemisia tridentata*) is always associated with a soil of rather light texture, very dry during the summer months, free from alkali salts and with a low water table. This *Artemisia* association occupies mainly the higher lands of the valley. Descending the valley toward the shore of Great Salt Lake, successive zones are traversed which are occupied by the following associations: (2) *Kochia vestita,* (3) *Atriplex confertifolia* (Shadscale), (4) *Atriplex confertifolia* and *Sarcobatus vermiculatus* (Greasewood), (5) *Allenrolfea occidentalis,* (6) *Distichlis spicata* (Salt Grass) and two species of *Salicornia.*

Where associations 2 and 3 occur the soil is very dry during the summer, but has a higher moisture capacity than in the *Artemisia* association and the subsoil is strongly saline. Under association 4 the soil becomes saline to the surface and the ground water table is relatively high. Associations 5 and 6 occupy the wet and highly saline soils near the level of the water surface of the lake and are interrupted by bare expanses covered with a crust of salts (chiefly sodium chloride).

The suitability for crop production of the different types of land in this valley can be predicted with much confidence from the character of the native growth.

MR. HARRY B. SHAW: *The Control of Seed Production in Beets.*

Practically all sugar-beet seed used in the United States is imported. Successful attempts have been made in Utah, Idaho and Washington to produce sugar-beet seed, but in other regions

such attempts have not been very successful, inasmuch as many of the plants have failed to mature seed. Observations were made to ascertain the cause of this. In order to make the subject readily comprehensible attention was invited to the surprising responsiveness of the beet to environment; the responses may be grouped as follows:

1. The wild beet, a winter annual, ripening and dropping its seed early in autumn. The seed germinates before winter sets in, consequently the young seedlings are for many weeks exposed to a comparatively low mean temperature. In early spring—coincident with rising temperatures—the seed stem is put forth, the paucity of foliage being conspicuous.

2. The wild annual brought into cultivation soon assumes the biennial habit; its growth being in every known way stimulated from the sowing of seed onwards; planting is carefully planned so that the young seedling shall escape protracted periods of low temperature. In response, the roots become storehouses and fail to develop reproductive parts.

3. The cultivated beet, a biennial, not alone through selection, but more especially because its environments are entirely changed; it is withheld from those periods of restrained growth seen to operate upon the wild beet in its native habitat; instead, its growth is stimulated.

4. The cultivated beet reverts to the annual habit, whenever it is exposed in the seedling stage to conditions more or less identical with those of the wild beet at the same stage of growth.

5. Even when the beet is planted out the second spring for the production of seed, there are occasions and localities which cause in those beets a greater or less tendency toward non-seeding, ranging from almost normal seed production to absolute foliage conditions.

6. When placed under conditions where growth stimulus is great and constant, as in a well-heated greenhouse, the cultivated beet becomes perennial in habit, producing, year after year, nothing but foliage.

Mr. Shaw sought in these varied manifestations a common factor, or group of factors, which acting at a critical period in the life of the plant, might be found to control the manner of its development. Experiments were carried on in Utah during 1912 to determine, if possible, the nature of the conditions responsible for the variations mentioned.

It was discovered that the condition absolutely necessary for the perfect development of the reproductive parts is a period of restrained growth in the bud rudiments of seedlings, or the buds in the crown of so-called mother beets. While in general this condition is brought about by low temperatures (a mean temperature of 38 to 45° F. apparently being required for the sugar beet) when prevailing for several weeks, the necessary degree of growth inhibition may be brought about by other factors, such as pathological conditions, drouth, starvation. The withdrawal of such a period of inhibited metabolism, according to degree, will result in the greater or less degree of approach to foliage conditions, as opposed to the development of reproductive parts.

Thus, by a study of climatic conditions, suitable locations where the production of seed may be assured, can be selected with a considerable degree of certainty. The proper time to plant the mother-beets can also be indicated, so that we may be reasonably certain that the beets will produce seed.

This necessity for a period of inhibited metabolism, and the fact that it may be brought about by the conditions mentioned, may explain the remarkable inflorescence of moribund fruit trees, or of trees that have been girdled, also the abnormal behavior of plants carried from a cool to a warm climate.

C. L. Shear,
Corresponding Secretary

Philosophical Society, University of Virginia
Mathematical and Scientific Section

The fifth meeting of the session of 1912–13 of the Mathematical and Scientific Section was held February 17.

Professor W. H. Echols read a paper entitled "The Evolutionary Construction of the Imaginary Power of a Number and Its Expression as the Exponential Function."

Professor Thomas L. Watson read a paper by himself and Professor Stephen Taber on "Magmatic Names Proposed in the Quantitative System of Classification for some New Rock Types in Virginia."

Professor Watson presented a second paper by himself and Mr. Justus H. Cline. The subject of this second paper was "Petrology of a Series of Igneous Dikes in Central Western Virginia."

Wm. A. Kepner,
Secretary

University of Virginia